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Introduction

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The Preliminary Edition of the *NASA Thesaurus* (December 1967) (NASA SP-7030) is being used as the authority for the indexing vocabulary that appears in the subject index to this issue. The terminology has been modified from the *Guide to the Subject Indexes for STAR* (NASA SP-7016), the authority used for the vocabulary to indexes published prior to 1968. The *NASA Thesaurus* should be consulted for a total picture of the current indexing vocabulary including associated cross reference structure. Only the subject terms that have been selected to describe the documents abstracted in this issue appear in the subject index. Copies of the *NASA Thesaurus* may be obtained from the Clearinghouse for Federal Scientific and Technical Information or the U. S. Government Printing Office at a price of $8.50 for the three-volume set.

Volume 6 Number 10 / May 23, 1968

TABLE OF CONTENTS

Subject Categories

Abstracts in the journal are grouped under the following categories: ***page:***

01 AERODYNAMICS
Includes aerodynamics of bodies, combinations, internal flow in ducts and turbomachinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion. **1455**

02 AIRCRAFT
Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **1457**

03 AUXILIARY SYSTEMS
Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems. **1459**

04 BIOSCIENCES
Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology. **1462**

05 BIOTECHNOLOGY
Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences. **1473**

06 CHEMISTRY
Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants. **1479**

07 COMMUNICATIONS
Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **1494**

08 COMPUTERS
Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics. **1502**

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation. **1505**

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories. **1507**

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations. **1511**

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion. **1513**

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences. **1518**

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras. **1526**

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; reliability; drafting; and materials fabrication, handling, and inspection. **1532**

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid-State. **1536**

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see : 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics. **1537**

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics. **1541**

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers. **1543**

20 METEOROLOGY
Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences. 1550

21 NAVIGATION
Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications. 1553

22 NUCLEAR ENGINEERING
Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems. 1554

23 PHYSICS, GENERAL
Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics, 20 Meteorology, and 29 Space Radiation. 1557

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR
Includes atomic, molecular and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation. 1560

25 PHYSICS, PLASMA
Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems. 1572

26 PHYSICS, SOLID-STATE
Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics. 1575

27 PROPELLANTS
Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems. 1583

28 PROPULSION SYSTEMS
Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants. 1584

29 SPACE RADIATION
Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear. 1587

30 SPACE SCIENCES
Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbits and trajectories. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles. 1589

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics. **1598**

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic. **1601**

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants. **1610**

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents. **1615**

SUBJECT INDEX I-1

PERSONAL AUTHOR INDEX I-59

CORPORATE SOURCE INDEX I-81

REPORT/ACCESSION NUMBER INDEX I-95

ACCESSION/REPORT NUMBER INDEX I-105

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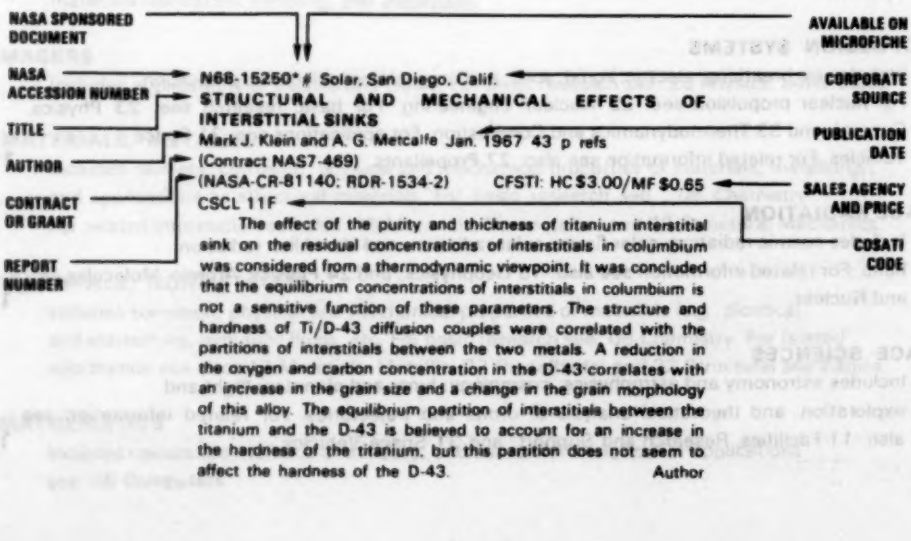
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Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
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The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

VOLUME 6, NUMBER 10 / MAY 23, 1968

Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N68-19538# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Aeronautical Engineering and Astronautics.
STEADY STATE SIMULATION STUDY OF THE FLOW INDUCED BY AN INTERNALLY PROPELLED VEHICLE IN AN INFINITE TUBE: SUPERSONIC VEHICLE
Duane E. Cromack Jun. 1967 30 p refs
(Contract C-117-66)
(TR-AE-6704; PB-176410) CFSTI: HC $3.00/MF $0.65

The flow induced in the wake of an internally-propelled supersonic vehicle or of a disturbance moving supersonically through an infinite tube is analyzed as a steady one-dimensional flow in the frame of reference of the vehicle or disturbance, with full account of heat transfer and dissipative effects. The governing equations are solved numerically. The results confirm that the flow can be steady if it is everywhere supersonic relative to the vehicle or disturbance. Author

N68-19732# Michigan Univ., Ann Arbor. Gas Dynamics Lab.
THE STRUCTURE OF WEAK NON-HUGONIOT SHOCK WAVES Final Report
Martin Sichel, Y. K. Yin, and Thomas S. David Jan. 1968 47 p refs
(Contract DA-31-124-ARO(D)-276; Grant DA-ARO(D)-31-124-G385)
(AROD-3537.5-E; Rept.-07146-3-F; AD-644772)

The object of the research program was to examine the effect of viscosity on transonic flow. Following the Introduction, Sections II and III of the report describe the personnel who were active in this program, and summarize the research which was completed. Author (TAB)

N68-19788# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
PRESSURE DISTRIBUTION ON A HYPERSONIC DELTA WING OF DIAMOND CROSS SECTION
A. I. Ormsbee Jul. 1967 14 p refs
(DAC-60715)

The disturbance region associated with a yawed hypersonic delta wing of diamond cross section was analyzed for zero angle of attack, and it is shown how angle of attack effects may be included. The hypersonic equivalence principle transforms the three-dimensional steady flow into an equivalent plane nonsteady flow in the cross-flow plane, and it was assumed that the shock wave attached to the leading edge is of finite strength and lies close to the body and the wing thickness was considered small. Boundary conditions are discussed and pressure distributions are reported. M.W.R.

N68-19791*# Wyle Labs., Inc., Huntsville, Ala.
AN EXPERIMENT TO EXAMINE THE EFFECT OF POROUS TRAILING EDGES ON THE SOUND GENERATED BY BLADES IN AN AIRFLOW Final Report
R. C. Potter Mar. 1968 74 p refs Supersedes (WR-67-20)
(Contract NAS1-6885)
(NASA-CR-66565; WR-68-6; WR-67-20) CFSTI: HC $3.00/MF $0.65 CSCL 01A

This report presents the results of an experimental program to examine the effects on the sound field radiated by a blade in a moving air stream, when the blade trailing edge is modified by use of a porous material. The objective was to examine a possible means of reducing the broad band noise radiated by compressor blades in axial flow compressors. The experiment was designed to reduce the "vortex shedding" noise produced by the uncorrelated pressure fluctuations at the blade trailing edge. The modified blades were placed in turn in the laminar and turbulent flow of a jet and compared to a solid control blade. The apparatus was contained within a reverberation room so that the total acoustic power generated could be measured. The results show that for a highly porous trailing edge a reduction in broad band noise radiated of up to three dB was possible. This was the greatest value achieved for a series of twenty different blade modifications, and while it indicated the possibility of reducing this "vortex shedding" noise, it did not seem to justify practical application to the axial flow compressors of jet engines. The reduction was noted for both when the blade was in a laminar and in a turbulent air flow, suggesting that this vortex shedding noise is a significant part of the noise formed in both cases. Author

N68-19954*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN INVESTIGATION OF EXTREMELY FLEXIBLE LIFTING ROTORS
Matthew M. Winston Washington Apr. 1968 28 p refs
(NASA-TN-D-4465) CFSTI: HC $3.00/MF $0.65 CSCL 01A

This investigation includes analytical and experimental studies of rotors with very low structural stiffness and single-surface, deformable airfoils. The analytical study focused on the planform and tip-mass requirements necessary to prevent luffing (fabric instability) of a completely flexible blade and included consideration of the

aeroelastic characteristics of flexible blades having chordwise stiffeners spaced along the blade. The experimental investigation focused on determining the hovering characteristics of a 30-foot-(9.144-meter-) diameter flexible rotor. The results of the analytical study indicate that very careful planform design and judicious choice of tip mass are required to prevent luffing on a completely flexible blade. Tip-mass requirements with the attendant increase in overall rotor weight indicate that large rotors of this type are not assured the performance benefits of low disk loadings that were initially expected. Although partial stiffening of the blade chord makes planform and tip-mass design requirements less critical, both types of flexible rotors may operate at disk loadings higher than initially expected, since rotor size-weight relationships may be dictated by requirements for aeroelastic stability. The experimental study indicates that low hovering efficiencies and high power consumption resulted from blade deformations and excessive twist; however, the aerodynamically-induced camber developed during operation provided high mean lift coefficients. Author

N68-20076# Royal Aircraft Establishment, Farnborough (England).
MEASUREMENT OF PRESSURES ON A DELTA WING OSCILLATING IN HEAVE AT A HIGH ANGLE OF INCIDENCE
R. F. A. Keating Oct. 1967 15 p refs
(RAE-TR-67241; AD-665097)

Previous measurements of leading-edge vortex position on a delta wing oscillating in heave have shown fair agreement with the phase lags predicted theoretically by Randall. In this report measurements of surface pressure are described for the same oscillating wing. The analysis shows that the cyclic phase lag in the pressure variations underneath the vortex field correlates well with a frequency parameter based on the distance back from the wing apex. The agreement with the previous flow observations is good. Author (TAB)

N68-20090# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Aachen (West Germany). Institut fuer Theoretische Gasdynamik.
ON THE ACOUSTIC THEORY OF SUPERSONIC FLOW PAST SLENDER BODIES OF REVOLUTION AT SMALL ANGLES OF ATTACK [ZUR AKUSTISCHEN THEORIE SCHLANKER ROTATIONSKOERPER IN ANGESTELLTER UEBERSCHALLSTROEMUNG]
P. Niederdrenk Jan. 1968 24 p refs In GERMAN; ENGLISH summary
(DLR-FB-68-03; DVL-698) CFSTI: HC $3.00/MF $0.65

In contrast to the hitherto existing treatments of the subject, the deviation of the Mach cone axis from the axis of symmetry of the body is considered. The boundary conditions are fulfilled correctly within the scope of the theory by applying a linear transformation to the customary solutions. Author

N68-20147 Pennsylvania State Univ., University Park.
A STUDY OF THE NORMAL FORCE AND PITCHING MOMENT FOR AN OSCILLATING, SUPERCAVITATING HYDROFOIL
Howard Richard Kelly (Ph.D. Thesis) 1966 262 p
Available from Univ. Microfilms: HC $11.95/MF $3.40 Order No. 67-5930

This investigation consists of a study of the forces and moments on a flat plate hydrofoil in two-dimensional steady, supercavitating flow, and of the oscillating forces and moments on an identical hydrofoil when oscillated in pitching and plunging motions. A 20° total-angle wedge hydrofoil was mounted in the test section of a water tunnel in which the flow was made two-dimensional by a suitable liner. The model was held stationary at incidence angles from 0° to 20° and the lift and drag forces and pitching moment were measured by a strain-gage balance. Water speeds from 25 to 45 feet per second and test-section static pressure from three to six psi allowed a variation in cavitation number from 0.18 to 1.20. Forces and moments were reduced to coefficient form and tabulated. A similar model was oscillated in the same tunnel at flow speeds of 30 to 40 feet per second and pressures from four to five psi. The oscillation had an amplitude of about 3° about a mean incidence angle of 12°. The oscillating component of normal force and pitching moment were measured with piezo-electric gages. Forces and moments were computed and reduced to coefficient form for comparison with theory. Dissert. Abstr.

N68-20226# ARO, Inc., Arnold Air Force Station, Tenn.
APPLICATION OF FREE-MOLECULE FLOW THEORY TO DETERMINE AERODYNAMIC FORCES ON CONES Final Report, Jun. 1966–Sep. 1967
Hrishikesh Saha Arnold Eng. Develop. Center Feb. 1968 526 p ref
(Contract AF 40(600)-1200)
(AEDC-TR-67-258; AD-665114)

Extensive computations of free-molecule force coefficients on cones are presented in tabular form. The results allow quick determination of free-molecule values of C sub L, C sub D, C sub A, and C sub N for a given cone geometry, speed ratio, and temperature ratio. It is assumed that the gas molecules are reflected diffusely from the cone surface. Author (TAB)

N68-20330*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF ANNULAR PLUG AND EXPANSION-DEFLECTION NOZZLES INCLUDING EXTERNAL FLOW EFFECTS AT TRANSONIC MACH NUMBERS
Robert A. Wasko Washington Apr. 1968 33 p
(NASA-TN-D-4462) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Experiments covered the Mach number range from 0.56 to 2.0 and included the effects of base bleed as well as variations in plug length and nozzle internal expansion. The full-length plug nozzle performed nearly constant and with optimum quiescence, while the expansion-deflection (ED) nozzle performed only similar to a conical convergent-divergent (CD) nozzle. Thus, the plug nozzle was altitude compensating, while the ED nozzle was not. Plug nozzle efficiency ranged from 98.4% at a pressure ratio of 68 (corresponding to sea-level altitude) to 99% at the design pressure ratio of 290. ED and CD nozzle efficiencies were, respectively, 92.3 and 92.6% at sea level, and 97.6 and 97.8% at the design point. Truncation of the plug nozzles with internal expansion to a nominal 21, 10, and 0% of full plug length resulted in decreased nozzle performance that varied from 96.4, 95.3, and 94.9% at sea level to 98.3, 97.0, and 96.8%, respectively, at the design point. Base bleed improved the truncated plug nozzles with internal expansion. However, ED nozzle performance improved only at pressure ratios above design. Elimination of internal expansion and external plug surface caused poor nozzle performance. Maximum performance loss due to external flow effects was 2.5% of the ideal thrust and occurred below Mach 1.0. Secondary flow reduced the performance loss to as little as 1.75% of ideal thrust. K.W.

N68-20366# National Physical Lab., Teddington (England). Aerodynamics Div.
CALCULATION OF SUBSONIC FLUTTER DERIVATIVES FOR AN ARROWHEAD WING WITH CONTROL SURFACES
Doris E. Lehrian 1 May 1967 74 p refs
(NPL-AERO-1230; ARC-29047) CFSTI: HC $3.00/MF $0.65

An oscillatory lifting-surface theory for subsonic flow is used to calculate the aerodynamic forces on an oscillating arrowhead wing of aspect ratio 2 with trailing-edge control-surfaces of varying span. The collocation method is outlined for simple harmonic motion of arbitrary mode and frequency and is applied for modes of plunging, pitching and control-rotation. The discontinuous upwash

in the control-surface problem is replaced by a smooth equivalent function. An alternative treatment for total forces, such as lift and pitching-moment, is provided by the reverse-flow theorem with collocation solutions calculated for the 'reversed wing' in appropriate modes. Values of the aerodynamic derivative coefficients are presented for a range of frequency at the Mach numbers 0.781 and 0.927. The variation of the pitching derivatives with frequency, Mach number and pitching axis is illustrated and shows good agreement with the results obtained by other collocation theories and by low-frequency wind-tunnel measurements. For the control-rotation mode, the calculated values of the indirect control derivatives indicate the good comparisons between the various methods of constructing equivalent upwashes and also the satisfactory comparison with the other collocation theories. Values of the direct control derivatives appear more sensitive and large variations in magnitude are associated with the different collocation methods and equivalent upwash treatments. Author (ESRO)

N68-20370*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LARGE-SCALE WIND-TUNNEL INVESTIGATION OF AN AIRPLANE MODEL WITH A TILT WING OF ASPECT RATIO 8.4, AND FOUR PROPELLERS, IN THE PRESENCE OF A GROUND PLANE

Stanley O. Dickinson, V. Robert Page, and Wallace H. Deckert Washington Apr. 1968 80 p refs
(NASA-TN-D-4493) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Aerodynamic characteristics of a large-scale model of a tilt-wing V/STOL transport aircraft are presented. The investigation was conducted in Ames 40- by 80-foot wind tunnel at various heights above a fixed ground plane. Free-stream Reynolds number varied from 0 to 2.9 million. Model configurations included wing tilt angles from 0° to 90°, trailing-edge flap deflections from 0° to 60°, and partial-span wing leading-edge slats. Results show ground proximity decreased lift up to 20 percent (depending on wing tilt angle), decreased drag, and increased nose-down pitching moment. Author

N68-20394# National Physical Lab., Teddington (England). Aerodynamics Div.

CALCULATIONS SHOWING THE INFLUENCE OF AERODYNAMIC DAMPING ON BINARY WING FLUTTER

N. C. Lambourne 6 Jul. 1967 24 p refs
(NPL-AERO-1236; ARC-29264) CFSTI: HC$3.00/MF$0.65

The influence of damping is examined by comparing the flutter critical speeds and frequencies obtained using the complete equations of motion and those obtained when all the damping terms are omitted. The calculations are made for binary flexure-torsion flutter of a wing in incompressible flow and the comparisons extend over ranges of values of the principal parameters. When the ratio of air density to wing density is high, the damping terms are found to raise the flutter speed by a large amount. But when the ratio of air density to wing density is low, a condition often occurring in practice, it appears that, over a wide range of parameter variation, the flutter speed obtained in the absence of damping is reasonably close to that obtained from the complete equations. Further experience is obviously needed before any general conclusion can be reached, but the present results offer some hope of reducing either the extent of, or the accuracy needed in, the aerodynamic information used for wing flutter calculations. It is pointed out that with constant aerodynamic coefficients the flutter speed for an undamped system is independent of the wing density. Author (ESRO)

N68-20461# Notre Dame Univ., Ind. Dept. of Aero-Space Engineering.

A WIND TUNNEL FREE FLIGHT TECHNIQUE TO DETERMINE LIFT AND DRAG OF A WING CONFIGURATION Final Report

V. P. Goddard and C. A. Campbell Nov. 1967 68 p refs
(Contract DA1HC-04-67-C0018)
(AROD-7065.1-TR; AD-665441)

Free-flight hypersonic wind-tunnel tests were made with thin delta-wing configurations to ascertain the feasibility of such a testing technique. A unique launcher system was developed that is capable of regulating the initial flight path angle, initial angle of attack, and the injection velocity. The aerodynamic coefficients of lift and drag were deduced from the recorded free-flight trajectories. Agreement between theory and test results were excellent. It is quite apparent that this testing method is a valuable and realistic research technique. Author (TAB)

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N68-19537# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.

FLIGHT EVALUATION OF DIRECT LIFT CONTROL AND ITS EFFECT ON HANDLING QUALITIES IN CARRIER APPROACH

Herman A. Mooij (M.S. Thesis) Dec. 1967 101 p refs
(Rept.-811)

The different ways of applying direct lift control in carrier power approach are investigated. Simulated carrier approaches were flown in a variable stability and lift Navion airplane at a closure speed of 110 knots. An environment of moderated natural turbulence and the carrier's turbulent wake was simulated. Data in the form of pilot Cooper ratings and commentary were obtained for configurations having several combinations of the slope of the lift curve and short period frequency. Control of direct lift either through a separate controller (DLC) or through the center stick was investigated. At low short period frequency, DLC appears to be the best way of using direct lift capability for low and medium values of L_α/V_0. At high short period frequency, either combination control or DLC, result in moderate improvement over longitudinal control with the elevator only. In a special case pure lift control with the center stick offers a major improvement. A deterioriation of pilot ratings was observed for combination control conditions with the same value of $1/T_{\theta_2}$ when doubling the slope of the lift curve from a low to a medium value; turbulence sensitivity in heave is the prime factor for this degrading trend. Author

N68-19620*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

REVIEW OF CAUSES AND ALLEVIATION OF LOW TIRE TRACTION ON WET RUNWAYS

Walter B. Horne, Thomas J. Yager, and Glenn R. Taylor Washington Apr. 1968 37 p refs
(NASA-TN-D-4406) CFSTI: HC$3.00/MF$0.65 CSCL 01B

Three main factors which cause loss of tire traction on wet runways, namely, dynamic hydroplaning, viscous hydroplaning, and tire tread rubber reversion are reviewed. Consideration is given to the interaction of certain variables such as pavement surface texture, runway water depth, tire tread design, vertical tire load, and tire inflation pressure with these factors. A method for measuring average texture depth of a runway surface is described and appears promising as a means of classifying runway surfaces as to

their slipperiness when wet. Finally, two promising methods for increasing tire traction on wet runways are discussed; namely, air jets placed in front of tires and pavement grooving. Author

N68-19750*# National Aeronautics and Space Administration, Washington, D. C.
VARIABLE STABILITY AIRCRAFT [AVIONS A STABILITE VARIABLE]
G. Klopfstein Mar. 1968 26 p Presented at the 28th Meeting of the Flight Mech. Group, AGARD, Paris, 10–11 May 1966
(NASA-TT-F-11679; AGARD-537) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The report describes the first French variable stability aircraft. The aircraft was designed by the "Centre d'Essais en Vol" and the "Société Francaise d'Equipements pour la Navigation Aérienne". Modifications to the airframe of the basic production type Mirage III B were made by "Avions Marcel Dassault". Methods for calculating the gains and methods used to check the simulation are presented. Author

N68-19815# Human Engineering Labs., Aberdeen Proving Ground, Md.
AIRCRAFT INSTRUMENT PANEL PLACEMENT
John A. Barnes Jan. 1968 19 p refs
(TN-2-68; AD-664750)

The placement of the aircraft instrument panel has been governed by the 1947 recommendations of the Armed Forces-NRC Vision Committee. This distance, 28 inches from eye to panel, is not always compatible with present-day aircraft designs. A criterion for determining the placement of the instrument panel is developed and the maximum allowable eye-to-panel distance is given in this paper. Author (TAB)

N68-19895# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
DISPLAY REQUIREMENTS STUDY FOR HELICOPTER IFR FORMATION FLIGHT Technical Report, 27 Jun. 1966–15 Jul. 1967
R. M. Nicholson, J. D. Wolf, and R. R. Clifford Jan. 1968 263 p
(Contract N00014-66-C-0362)
(Rept.-12543-FR1; AD-665277)

The objective of the program was to define and to demonstrate display formats appropriate for helicopter IFR formation flight. The report describes the human factors analysis which led to the development of three alternative display designs. A program of closed-loop computer simulations is also described in which pilots performance on the alternative displays was evaluated during simulated IFR formation flights. Evaluations were made of pilot performance under various levels of simulated turbulence, under different levels of pilot workload on a concomitant task and under four conditions of simulated system failures. The results of the study indicate that, within the constraints of the simulation program, manual IFR formation flight is feasible. The comparison of the alternative display formats indicated that the quickened plan-position display format yielded the best performance data under nearly all of the conditions that were tested. A display feasibility analysis was performed which indicated that the technology required to develop the selected display formats is within the present state-of-the-art. Author (TAB)

N68-19982# Kaman Aircraft Corp., Bloomfield, Conn.
UH-2 HELICOPTER HIGH-SPEED FLIGHT RESEARCH WITH LIFT AND THRUST AUGMENTATION
W. E. Blackburn and A. D. Rita Oct. 1967 80 p refs
(Contract DA-44-177-AMC-151(T))
(KAMAN-AC-RN-R-601B; USAAVLABS-TR-67-12; AD-664791)

The report presents results of a flight test program conducted using a UH-2 helicopter with a fully articulated, servo-flap controlled rotor and provided with a YJ-85 jet engine for thrust augmentation and with wings for lift augmentation. The effect of lift augmentation on airspeed limitations imposed by rotor blade stall or compressibility was investigated, and performance, flying qualities, structural loads, and vibrations were examined. A maximum level-flight speed of 190 knots was achieved. It was determined that the airspeed is limited by power available. Although compressibility effects were encountered at high rotor speed, the airspeed envelope was expanded by reducing rotor speed. Lift augmentation is shown to substantially reduce rotor and airframe loads and vibrations while providing an expanded speed and maneuvering envelope. The suitability of a fixed-wing incidence angle was demonstrated, although it is concluded that further investigation of rotor and aerodynamic surface controls may be required to provide optimum control. Correlation of flight test results and those predicted by analytical study is presented in areas of performance, controllability, and limit flight speeds. In general, analytical methods for predicting these characteristics are shown to be satisfactory. Author (TAB)

N68-20082# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
A SELF-ADAPTIVE AIRCRAFT PITCH RATE CONTROL SYSTEM EXPLOYING DIFFERENCE EQUATIONS FOR PARAMETER IDENTIFICATION
Ian Stuart Parry (M.S. Thesis) Jun. 1967 114 p refs
(GA/EE/67-2; AD-665126)

In a high performance aircraft in Mach number, angle of attack and altitude can cause a large variation in the short-period transfer function. To provide the pilot with a consistant pitch rate control characteristic an airborne computer, with inputs of elevator deflection angle and pitch rate is used to identify and track changes in the elevator effectiveness. Simulation with an aircraft whose elevator effectiveness varied over a range of 240:1 showed that the desired loop gain was maintained within a factor of two for both pilot command inputs and for random wind gust disturbances of root-mean-square magnitude 20 ft/sec. Author (TAB)

N68-20246# Federal Aviation Administration, Washington, D. C. National Transportation Safety Board.
ANNUAL REVIEW OF U. S. GENERAL AVIATION ACCIDENTS OCCURRING IN CALENDAR YEAR 1966
Nov. 1967 175 p
(PB-177089) CFSTI: HC $3.00/MF $0.65

In the analysis of accidents a collision between aircraft is treated as one accident in the overall total. However, a complete analysis and coding is made on each aircraft involved in a collision. This produces two aircraft accident records, one for each aircraft. These records contain the same broad categories of coded data. The specific entries, such as type of aircraft, kind of flying, phase of operation, however, may or may not be common to each aircraft. As a result, the number of accidents may differ in the various tables depending upon whether or not collisions are involved and if so, whether or not the selected items of data are common to each aircraft. For example: In a table showing the number of accidents occurring in the various kinds of flying, if both of the colliding aircraft were conducting Pleasure Flying, one accident would appear in the Pleasure Flying column. However, if one aircraft was engaged in Pleasure Flying and the other was conducting Dual Instruction, the accident would appear twice, once in the Pleasure Flying column, and once in the Dual Instruction column. Author

N68-20314*# Goodyear Aerospace Corp., Akron, Ohio. Martin Co., Denver, Colo.
PEPP BALLUTE DESIGN AND DEVELOPMENT Final Report
22 Sep. 1967 145 p refs Prepared for Martin Co.
(Contract NAS1-6703)
(NASA-CR-66585; GER-13388) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The Supersonic Planetary Entry Decelerator Program 18-foot ballute design is analyzed with respect to aerodynamic, structural, and thermal requirements. Also included are results from both in-plant and development testing. Author

N68-20315*# Pioneer Parachute Company, Inc., Manchester, Conn.
FIFTY-FIVE FOOT DIAMETER RINGSAIL PARACHUTE. PLANETARY ENTRY PARACHUTE PROGRAM Final Technical Report
F. J. Stone Dec. 1967 84 p Prepared for Martin Co.
(Contract NAS1-6703)
(NASA-CR-66588; E-0082-RT/1) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The Planetary Entry Parachute Program 55-foot nominal diameter ringsail parachute design is analyzed with respect to material strengths, shock loading, and material stress analysis. This report summarizes calculations on which the design is based, material and joint test data, stress analysis procedures, and system weight and center of gravity location calculations. A materials properties section is also included and basic parachute system configuration and dimensions are defined. Author

N68-20316*# Schjeldahl (G. T.) Co., Northfield, Minn.
DGB 40 FT PARACHUTE Final Report
Reinhold Lemke 13 Oct. 1967 73 p refs Prepared for Martin Co.
(Contract NAS1-6703)
(NASA-CR-66587; PR25-36-SPED-1) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The design presented describes a 40-foot nominal diameter Disk-Gap-Band parachute tested as a candidate in the Supersonic Planetary Entry Decelerator Program. This report includes design requirements, estimates of maximum expected loads on the parachute, parachute configuration, stress analysis, moment of inertia, and component structural test data. Author

N68-20317*# Pioneer Parachute Company, Inc., Manchester, Conn. Martin Co., Denver, Colo.
FORTY FT-DIAMETER RINGSAIL PARACHUTE PLANETARY ENTRY PARACHUTE PROGRAM Final Technical Report
F. J. Stone [1967] 95 p Prepared for Martin Co.
(Contract NAS1-6703)
(NASA-CR-66586; E-0067-RT/2) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The Planetary Entry Parachute Program 40-foot nominal diameter ringsail parachute design is analyzed with respect to material strengths, shock loading, and material stress analysis. This report summarizes calculations on which the design is based, material and joint test data, stress analysis procedures, and system weight and center of gravity location calculations. A materials properties section is also included and basic parachute system configuration and dimensions are defined. Author

N68-20319*# Schjeldahl (G. T.) Co., Northfield, Minn.
SIXTY FOOT DIAMETER DGB PARACHUTE PLANETARY ENTRY PARACHUTE PROGRAM Design Report
Reinhold A. Lemke, Ronald J. Niccum, Richard D. Moroney, and Theodore J. Neuhaus 14 Jul. 1967 77 p refs Prepared for Martin Co.
(Contract NAS1-6703)
(NASA-CR-66589) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The design presented describes a 65-foot nominal diameter disk-gap-band parachute tested as a candidate in the Planetary Entry Parachute Program. This report includes design requirements, estimates of maximum expected loads on the parachute, parachute configuration, stress analysis, moment of inertia, and component structural test data. Author

N68-20320*# Raven Industries, Inc., Sioux Falls, S. Dak.
PLANETARY ENTRY PARACHUTE PROGRAM
E. W. Boettcher [1967] 164 p Prepared for Martin Co.
(Contract NAS1-6703)
(NASA-CR-66590; R-1767) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The Planetary Entry Parachute Program 54.45-foot diameter cross parachute design is analyzed with respect to material strengths, shock loading, and material stress analysis. This report summarizes calculations on which the design is based, material and joint test data, stress analysis procedures, and system weight and center of gravity location calculations. A materials properties section is also included and basic parachute system configuration and dimensions are defined. Author

N68-20365# Aeronautical Research Council (Gt. Brit.).
PHYSICAL CHARACTERISTICS OF THE SONIC BANGS AND OTHER EVENTS AT EXERCISE WESTMINSTER
D. R. B. Webb and C. H. E. Warren London HMSO 1967 43 p refs Supersedes RAE-TR-65298; ARC-27645
(ARC-R&M-3475; RAE-TR-65248; ARC-27645) CFSTI: HC $3.00/MF $0.65

Exercise Westminster was a demonstration of sonic bangs, together with some explosive bangs and flyovers by a jet aircraft, staged for an invited audience. This report describes how the exercise was conducted from the operational point-of-view, and what monitoring measurements were made. An analysis of the physical characteristics of the sonic bangs and other events is made. Author (ESRO)

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N68-19606*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
GAS BEARING APPLICATIONS IN SPACE POWER TURBOMACHINERY
W. J. Anderson [1968] 57 p refs
(NASA-TM-X-57367) CFSTI: HC $3.00/MF $0.65 CSCL 10B

NASA has been developing and evaluating two turbocompressors: one utilizing a radial flow compressor and a radial flow turbine, the other utilizing an axial flow compressor and an axial flow turbine. In addition, a turboalternator on a separate shaft is being developed. These three designs involve the use of journal bearings and thrust bearings. Presented in this paper is a detailed discussion of design philosophy, operating conditions, power losses, effects of rotor unbalance, rotor critical speeds, performance, and development problems. K.W.

N68-19707*# Radio Corp. of America, Harrison, N. J.
SOLAR THERMOELECTRIC GENERATOR DESIGN AND PANEL DEVELOPMENT PROGRAM Fabrication Report
L. H. Gnau 20 Mar. 1968 65 p
(Contract NAS3-10800)
(NASA-CR-72386; RCA-647FR-32068) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Three flat-plate sections of a developmental silicon-germanium solar thermoelectric generator, each with an area of 12.25 square inches, were fabricated in accordance with the Task II design for a 150-watt Solar Thermoelectric Generator. The development

effort required to achieve fabrication of the feasibility sections is described. The fabrication and assembly process specifications for the test sections are also considered in detail, supplemented by engineering layout drawings of the generator and its components. Author

N68-19805# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.
DESIGN, FABRICATION AND TESTING OF VENTED, RECHARGEABLE SILVER CADMIUM CELLS Final Report, May 1966–Aug. 1967
S. Charlip Dec. 1967 47 p
(Contract DA-36-039-AMC-03359(E))
(ECOM-03359-F; AD-664777)

The objectives of this program were to design, build, and test vented silver-cadmium cells, in four sizes with a common base area. Four cell types were constructed with the following rated capacities at the five-hour rate: Type 2 - 7 ampere-hours; Type 3 - 15 ampere-hours; Type 4 - 22 ampere hours; Type 5 - 31 ampere hours. The report gives the capacities obtained from engineering evaluation tests for capacity, room and high temperature storage, cold temperature, and data on cycle life. The test results indicate that the silver-cadmium cells constructed from pasted positive and pressed negative electrodes should meet the functional test requirements. TAB

N68-19913*# Union Carbide Corp., Parma, Ohio. Research Lab.
DEVELOPMENT OF SECONDARY CADMIUM-OXYGEN CELLS FOR SPACECRAFT APPLICATIONS Quarterly Report, 1 Jul.–30 Sep. 1967
30 Sep. 1967 30 p ref
(Contract NAS5-10384)
(NASA-CR-93835; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Continuing programs designed to determine cell characteristics of cadmium-oxygen cells are reported. A two-electrode cell structure utilizing an oxygen electrode and an electrodeposited cadmium electrode gave poor cycle life on a two-hour charge/two-hour discharge regime. Cell failure was due to oxygen electrode deterioration. A three-electrode cell utilizing an oxygen electrode, an electrodeposited anode, and a third electrode for charging has also shown oxygen electrode limitation, but has given cycle life in the range of 200 to 500 cycles on the two-hour charge/two-hour discharge regime. Cell tests have been complete discharge tests (initially to 0.2 volt and later to 0.4 volt) at constant current. Tests with both types of cells are being run on a 24-hour charge/24-hour discharge regime. No problems or failures have occurred. The two-electrode cell has completed 15 cycles and the three-electrode cell has completed 39 cycles. Cells have been built for 0°C and 40°C tests. The cadmium electrodeposition process has been used to produce anodes with approximately four times the capacity of the original stock anodes. Cycle life and capacity characteristics are being evaluated. Author

N68-19929*# Northern Research and Engineering Corp., Cambridge, Mass.
ANALYSIS OF GEOMETRY AND DESIGN POINT PERFORMANCE OF AXIAL FLOW TURBINES. PART 3: DESIGN ANALYSIS OF SELECTED EXAMPLES Final Report
A. F. Carter and F. K. Lenherr 29 Feb. 1968 77 p refs
(Contract NAS3-9418)
(NASA-CR-72385; NREC-1125-3, Pt. 3) CFSTI: HC $3.00/MF $0.65 CSCL 10A

This report is concerned with the application of a computer program to the analysis of turbine design requirements. The report presents the results of a general investigation of the effects of changes in the radial variation of design specifications such as the stator exit tangential velocity and the work output. These results are intended to provide guidance to future users of the program who are presented with considerably more freedom in turbine design using a stream-filament approach to the design problem. The report also presents the results of a specific investigation of the geometry and design-point performance of four turbines which satisfy a selected design requirement. The four turbines cover a range of tip diameters from a value consistent with a conservative design to a value which is 75 per cent of that selected for the conservative stage. The performance predictions show a 5.6 per cent drop in total-to-total efficiency and a 9.2 per cent drop in total-to-static efficiency for the increase in stage loading which accompanies the diameter reduction. Author

N68-20045*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE FEASIBILITY OF WIRELESS POWER TRANSMISSION FOR AN ORBITING ASTRONOMICAL STATION
William J. Robinson, Jr. 15 Feb. 1968 44 p refs
(NASA-TM-X-53701) CFSTI: HC $3.00/MF $0.65 CSCL 10B

An examination is made of the feasibility of using microwave or laser energy for wireless transfer of power from a manned, Earth-orbiting central station to unmanned astronomical substations. This is a recent conception, and details of a power-transfer system have not been established. Therefore, the possibility of wireless power transfer is judged on the basis of the state of research and development in power generation, transmission, and conversion. Author

N68-20276*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYTICAL INVESTIGATION OF SUPERSONIC TURBOMACHINERY BLADING. 2: ANALYSIS OF IMPULSE TURBINE-BLADE SECTIONS
Louis J. Goldman Washington Apr. 1968 23 p refs
(NASA-TN-D-4422) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The geometric characteristics of supersonic impulse turbine-blade sections were investigated. The blade sections were designed to produce vortex flow conditions within the blade passage. The effects of the lower- and upper-surface Mach numbers M_l and M_u, inlet flow angle β_i, and specific-heat ratio γ on the geometric characteristics were studied over an inlet Mach number range of 1.5 to 5.0. Blade design limitations imposed by consideration of supersonic starting and flow separation problems as well as restriction of the axial velocity to subsonic values were also investigated over the same Mach number range. The results indicated that the lower-surface Mach number level M_l and the inlet flow angle β_i had a significant effect on blade shapes, whereas the upper-surface Mach number M_u did not. For similar surface Mach numbers the effect of specific-heat ratio γ on blade shape was small. Increasing M_l or decreasing β_i resulted in thinner blades. The blade solidities σ were affected significantly by all the design parameters. Increasing M_l resulted in an increase in σ, while increasing either M_u or β_i caused σ to decrease. For similar surface Mach numbers, increasing γ tends to increase σ. Although the design limitation considered herein places severe restrictions on the freedom on choice of the design parameters, it was still possible to obtain blades of reasonable shape and solidities that meet these restrictions. Author

N68-20344*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DISCHARGE CHARACTERISTICS OF SOME COPPER OXIDE–MAGNESIUM THERMAL CELLS
Lawrence H. Thaller Washington Apr. 1968 23 p refs
(NASA-TN-D-4306) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Primary thermal cells were discharged at 450°C for periods ranging from 24 to 290 hours. These cells employed magnesium (99.8 percent) as the anode material. The cathode material was

the wire form of cupric oxide, which is about 80-mole-percent cupric oxide with the remainder cuprous oxide. The electrolytes consisted of 59-mole-percent lithium chloride with the remaining 41-mole-percent mixtures of potassium chloride and cesium chloride ranging from pure potassium chloride to pure cesium chloride. The average capacity of the cells was 15 ampere-hours (5.4×10^4C). The service life was limited by self-discharge arising from internal chemical reactions and short circuits. In this work, several features of cell design were altered in order to reduce self-discharge. A woven glass fabric separator was successful in eliminating the internal short circuits. Self-discharge from internal chemical reaction was reduced by increasing the electrode spacing and by adding CsCl to the electrolyte. The former increased the distance that electrode materials had to diffuse before reaction, and the latter reduced the diffusion coefficient. With these improvements, the rate of self-discharge was reduced from 200 milliamperes to less than 1 milliampere with a corresponding increase in cell resistance from 0.2 to 2.0 ohms. Service lives up to 12 days were achieved. Author

N68-20363*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INVESTIGATION OF THE USE OF THE LUNAR SURFACE LAYER TO STORE ENERGY FOR GENERATING POWER DURING THE LUNAR NIGHT
Gerald J. Barna and Roy L. Johnson Washington Apr. 1968 19 p
(NASA-TM-X-1560) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A solar concentrator and a surface heat exchanger with a coating having a high ratio of solar absorptivity to thermal emissivity were used to increase the thermal input to the storage bed during the lunar day. A Rankine cycle system was selected as the conversion device; the boiling temperature of the cycle varied from 580° to 760°R. To cover a range of possibilities, dry sand in a vacuum, pumicite, basalt lava, and basalt rock were considered. For a powerplant conversion efficiency of 0.135, the required specific storage bed area for basalt rock was approximately 37.2 m^2/kW_e for a boiling temperature of 560°R, more than 2 times as large for basalt lava, more than 6 times as large for pumicite, and about 40 times as large for dry sand. Raising the cycle boiling temperature was studied for basalt rock and basalt lava. Throughout the study assumptions favorable to the thermal energy storage device were used. It was concluded that the possibility of developing an attractive thermal energy storage device using this concept does not appear promising. K.W.

N68-20410*# Clevite Corp., Cleveland, Ohio. Electronic Research Div.
CDS SOLAR CELL DEVELOPMENT Interim Technical Report
F. A. Shirland, W. K. Bower, and J. R. Green 29 Feb. 1968 87 p refs
(Contract NAS3-9434)
(NASA-CR-72382) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The present program's major objectives were: cell design improvement (including the conductive plastic substrate, increasing area utilization, and larger cells); higher cell efficiencies; characterizing the CdS thin film cell (particularly its stability); and operating a cell fabrication line to make 100 cells per month. Part way into this program work on the cell design improvements was reduced and increased efforts were placed on characterizing cell stability and on achieving better control over the process of fabricating the cells. The processes for attaching the grid and for cementing the cover plastic were singled out for additional development. Still further into the contract it became evident that the cells being fabricated were not remaining stable when placed in a vacuum chamber and temperature cycled to simulate the conditions expected on a space vehicle in a low altitude earth orbit. A major shift in emphasis was made therefore toward determining the causes for cell failures during vacuum thermal cycling. During this reporting period additional tooling and processing facilities were provided and proved-in, as part of a separate Company funded program, which increased cell fabrication capacity to the level of 100 cells per 8-hour day. This was carried out successfully retaining essentially the same cell design and fabrication process. Author

N68-20432*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A 23.4 SQUARE-FOOT (2.17-SQ-M) CADMIUM SULFIDE THIN-FILM SOLAR CELL ARRAY
Henry W. Brandhort, Jr. and Adolph E. Spakowski Washington Apr. 1968 11 p refs
(NASA-TM-X-1519) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A large film solar cell array was built to explore the construction problems associated with the assembly of flexible, large-area solar cells. The array contains 378 cells, is 7 feet long and 3.35 feet wide, and weighs 1.76 pounds. The array is extended vertically from a storage drum by self-extending booms. In air mass 1 sunlight at 25°C the array output was 43.8 watts per pound of cells. The overall array had an efficiency of 3.55 percent and a cell packing factor of 0.94. Efficiencies of cells used in the array ranged betweed 3.0 and 5.5 percent, and no cell selection was made during assembly. Cell series connections had a resistance of less than 0.5 milliohm and a tensile strength to rupture of 70 pounds. The demonstration model has been extended and retracted over 500 times with no damage to either cells or connections. Author

N68-20492# New Zealand. Dept. of Scientific and Industrial Research, Wellington. Physics and Engineering Lab.
A 1.5 KW INVERTER FOR 110 VOLTS, 3 PHASE AT 400 CYCLES
M. J. Beale, A. R. Morman, and R. A. Morris [1967] 10 p ref
(TN-199) CFSTI: HC $3.00/MF $0.65

Operation, power supply and circuitry of an inverter are described which is intended to run a low temperature generator requiring 110 volts 3-phase 400 cycle power. Author (ESRO)

N68-20541 Illinois Univ., Urbana.
A CAPACITIVELY COUPLED BISTABLE GAS DISCHARGE CELL FOR COMPUTER CONTROLLED DISPLAYS
Robert Harry Willson (Ph.D. Thesis) 1966 69 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-6776

The capacitively coupled gas cell is made from a sandwich of three thin glass panels. A hole in the center panel forms the discharge cell and transparent electrodes on the outer surfaces of the outer panels are capacitively coupled into the cell. The ratio of the firing voltage to the sustaining voltages has been measured for a number of cells with different gases and different pressures. In certain gas mixtures in which the discharge is very rapid this ratio has been observed to be as large as 1.8. For a cell which is .025 cm thick and .013 cm in diameter, with 300 Torr of neon and 20 Torr of nitrogen, the discharge is quenched 50×10^{-9} seconds after it is initiated and even though the duty cycle is 1/100, the average light is sufficiently intense for display purposes. In neon, the discharge develops slowly and the voltage separation is small. We suggest that photon bombardment of the negative surface controls the rapid discharge while, in the slower discharge, ion bombardment of the negative surface controls the discharge. Dissert. Abstr.

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N68-19582 Pittsburgh Univ., Pa.
THE EFFECTS OF PHENFORMIN HYDROCHLORIDE ON OXYGEN DEPRIVATION IN RATS AT SIMULATED HIGH ALTITUDE
Robert Louis Powell (Ph.D. Thesis) 1966 75 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-7155

An inexpensive decompression chamber capable of accommodating ten rats at a simulated altitude of 29,000 feet (240 mm Hg pressure) is described. Methods for recording physiological parameters such as blood pressure, electroencephalogram, electrocardiogram, respiratory rate, and blood gas composition of animals at simulated high altitude are also described. Phenformin HCl afforded increasing protection from the lethal effects of hypoxia in doses of 18.75, 37.5, and 75 mg/kg when administered orally, 4 hours prior to decompression, to male Wistar rats. However, at a dose level of 150 mg/kg, protection declined. It is postulated the phenformin HCl protects rats from the detrimental effects of hypoxia through a complex series of effects including increased peripheral resistance resulting in increased central perfusion, increased ventilation, decreased alkalosis in response to hypoxia, and possibly by decreasing norepinephrine levels in the heart. Dissert. Abstr.

N68-19656# Oak Ridge National Lab., Tenn.
RADIATION DOSIMETRY, PART 4
J. A. Auxier *In its* Health Phys. Div. Oct. 1967 p 183–230 refs (See N68-19653 10-05)

Reported research covers the areas of: (1) *Ichiban Studies*—radiation attenuation and neutron energy spectrum measurements at Japanese laboratory; (2) *Spectrometry and Dosimetry Research*—possible nuclear accident dosimeter, recoil particle energy spectra, intermediate neutron energy spectrometer, and LiI spectrometry; (3) *Dosimetry Applications*—glass dosimetry, solid state track detectors, activation analyses in animals, neutron production in graphite, copper and tantalum targets, various dose calculations, etc.; and (4) *Health Physics Research Reactor and Low Energy Accelerator Operations.* G.G.

N68-19657# Oak Ridge National Lab., Tenn.
INTERNAL DOSIMETRY, PART 4
W. S. Snyder *In its* Health Phys. Div. Oct. 1967 p 231–288 refs (See N68-19653 10-05)

Described studies pertain to: (1) *Internal Dose Estimation*—energy calculations for internal radioactive decay caused by gamma radiation, variation of dose in man from exposure to gamma ray point source, body retention model for cesium, administration of labeled neohydrin dose, and excretion data analysis to predict body uptake of plutonium; and (2) *Stable Element Metabolism*—intake and excretion of stable elements, and tissue analysis. G.G.

N68-19748*# National Aeronautics and Space Administration, Washington, D. C.
MECHANISMS OF REGULATION OF THERMAL HOMEOSTASIS IN THE WORK PROCESS [MECANISMELE REGLARII HOMEOSTAZIEI TERMICE IN PROCESUL MUNCII]
N. Gavrilescu and M. Hilt Apr. 1968 4 p Transl. into ENGLISH from Fiziol. Norm. Patol. (Rumania), v. 12, no. 4, 1966 p 297–300
(NASA-TT-F-11635) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Thermal homeostasis involves numerous regulatory mechanisms. The thermoregulatory systems exhibit a duality, both topographic and functional, in that the centers which react to heat and to cold are not colocated. Specific mechanisms by which the body reacts to heat and cold are described. Author

N68-19802*# Techtran Corp., Glen Burnie, Md.
EFFECT OF VARIOUS DRINKING PATTERNS ON DIURESIS UNDER HIGH AIR TEMPERATURE AND PHYSICAL STRESS CONDITIONS [VLIYANIYE RAZLICHNYKH PIT'YEVYKY REZHIMOV NA DIUREZ V USLOVIYAKH VYSOKOY TEMPERATURY VOZDUKHA I FIZICHESKOY NAGRUZKI]
F. T. Yeronin Washington NASA Mar. 1968 8 p refs Transl. into ENGLISH from Fiziol. Zh. SSSR (Moscow), v. 49, no. 10, 1963 p 1249–1253
(Contract NASw-1695)
(NASA-TT-F-11605) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Tests were made to find the effect of heat and work on diuresis for three drinking patterns. Diuresis decreased with each hour in all tests for all drinking patterns, while the specific gravity increased. Losses from the skin and lungs were about 4.7% of the average body weight. Dehydration, caused chiefly by heavy perspiration, affects diuresis, but the main cause of reduced diuresis is reduced blood supply to the kidneys. Economization of water by reduced diuresis is only about 5% of total water losses. Diuresis did not differ greatly for the various drinking patterns. Anuria was not observed. Author

N68-19823*# National Aeronautics and Space Administration, Washington, D. C.
QUANTITATIVE RELATIONSHIP BETWEEN STIMULUS AND EFFECT IN THE STATIC ORGAN [QUANTITATIEVE BETREKKING TUSSCHEN PRIKKEL EN EFFECT BIJ HET STATISCH ORGAAN]
Willem Mulder Mar. 1968 111 p refs
(NASA-TT-F-11489)CFSTI: HC $3.00/MF $0.65 CSCL 06C

A literature survey is presented on the experimental data pertaining to static sensations and to the reflexes stimulated by the labyrinth. To show the quantitative relationship between stimulus and effect in the static organ, experiments were conducted on the otolith organs and on the semicircular canals. Pikes, frogs, turtles, and guinea pigs were used. The acceleration stimulus was kept as uniform as possible, and its effect was determined by recording the reflexes or determining the threshold of the sensations. With respect to reflexes in man, the reflex time of the rotation nystagmus was measured. Data are presented on the minimum perception, differentiation threshold, merging of rotation sensations, and progress of the sensation. A reference bibliography is included. M.G.J.

N68-19842# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
A STUDY OF THE PRIMATE VESTIBULAR SYSTEM
Charles S. Lessard (M.S. Thesis) and James R. Gnuse (M.S. Thesis) Jun. 1967 132 p refs
(GGC/EE/67-6; AD-665132)

A constant-speed, feedback-controlled apparatus suitable for flight in zero-g aircraft, was designed, modeled, tested and constructed for direct, continuous measurement and readout of eyeball counterroll. The results, using Rhesus monkeys as subjects, were compared with human measurements obtained through an indirect system and were found to be qualitatively similar. Transient responses to a step angular velocity were observed to diminish. Amplitude shifts, bias drifts, and variations in the magnitude of the counterrolling were recorded and adaption to consecutive stimuli and suppression of the vestibular response were observed. Author (TAB)

N68-19844# School of Aerospace Medicine, Brooks AFB, Tex. Aerospace Medical Div.

EFFECTS OF ACETAZOLAMIDE ON PHYSIOLOGIC AND SUBJECTIVE RESPONSES OF MEN TO 14,000 FEET Research Report, Apr.–Sep. 1966

Richard S. Kronenberg and Stephen M. Cain Sep. 1967 28 p refs Submitted for publication

(SAM-TR-67-81; AD-664901)

A study was carried out to determine the effectiveness of low doses of acetazolamide in ameliorating the symptoms of altitude sickness. Subjects were placed in a low pressure chamber at either 14,000 ft. or 3,000 ft. for 24 hours. Before entering the chamber each subject took a total of 750 mg. of acetazolamide or a placebo. During their 24-hour stay, the subjects filled out a questionnaire designed to evaluate their state of well-being. End-tidal PCO2 was measured, and electrodes were applied for monitoring respiratory pattern and EEG. Subjects were given a ranking of 1 (worst) to 4 (best) comparing individual clinical states. Samples of arterial blood and cerebrospinal fluid were obtained and analyzed for pH, PO2, PCO2, CO2, HCO3(-), and lactate. Twenty-four-hour urine volumes were analyzed for Na, K, and 17-hydroxycorticosteroids. Acetazolamide significantly lowered arterial and CSF HCO3(-), arterial and end-tidal PCO2, and arterial pH. The mean arterial PO2 was higher in those receiving acetazolamide, but the increase was not significant ($P < .10$). Pretreatment with acetazolamide was of sufficient clinical benefit to allow its recommendation prior to altitude exposure. Author (TAB)

N68-19949 Maryland Univ., College Park.

MIGRATION AND TRAPPING OF EXCITATION QUANTA IN PHOTOSYNTHETIC UNITS

Robert Milton Pearlstein (Ph.D. Thesis) 1966 110 p

CSCL 06C Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-6143

The cooperative process in which excitation quanta, initially absorbed anywhere in the photosynthetic pigment aggregates, are efficiently transported to specialized trapping sites is treated as the random migration and trapping of localized excitons. The major pigment component, chlorophyll-a in green plants, forms a network of interacting molecules with N molecules per trap; relaxation of the migratory excited state in the entire network is effected by the traps. A set of N Pauli-type, coupled master equations governs the exciton motion, which is diffusive in character. To allow for the possibility that the pigment layers may be multimolecular, both two- and three-dimensional networks are considered. The master equations are solved approximately for regular lattices, using a diffusion equation and radiation boundary condition at each trap. Dissert. Abstr.

N68-19957 California Univ., Berkeley.

THE ROLE OF CHLOROPHYLL AS A CHEMICAL INTERMEDIATE IN PHOTOSYNTHESIS

Marianne Patterson Byrn (Ph.D. Thesis) 1966 100 p

Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-5016

The work in this thesis evaluates several chemical mechanisms proposed in the literature using isotope tracers, and a new mechanism is proposed and experimental evidence in its favor is presented. Deuterium and NMR are used to determine the ability of the delta and the 10 position of chlorophyll *a*. Oxygen 18 and infrared were the means of evaluating proposals involving the carbonyl group of the isocyclic ring of chlorophyll *a* and *b*. Model compounds relating to the structure of chlorophyll (cyclic ketone, aromatic aldehydes and beta-ketoesters) were studied to determine the lability of carbonyl groups to hydration. Chlorophylls and chlorophyll derivatives were then examined, and their exchange properties are discussed in relation to the model compounds. Dissert. Abstr.

N68-19968*# Miami Valley Hospital, Dayton, Ohio. Dept. of Research.

THE POTENTIAL HAZARD OF STAPHYLOCOCCI AND MICROCOCCI TO HUMAN SUBJECTS IN A LIFE SUPPORT SYSTEMS EVALUATOR WHILE ON A SIMULATED GT-7 MISSION Final Report, 19 Sep.–1 Nov. 1965

Leonard P. Lotter and Bonnie S. Horstman Wright-Patterson AFB, Ohio AMRL Sep. 1967 33 p refs

(NASA Order R-85; Contract AF 33(657)-11716)

(NASA-CR-93778; AMRL-TR-67-45; AD-664909) CFSTI: HC $3.00/MF $0.65 CSCL 06I

Four human male subjects participated in a 6-week simulated aerospace study and during confinement were kept under controlled metabolic conditions. During this time 28 consecutive days were spent in a Life Support Systems Evaluator. The subjects ate fresh, heat processed, freeze dehydrated, and compressed bite sized foods while exposed to simulated aerospace stress of confinement, wearing an unpressurized pressure suit, experimental diet, and minimal personal hygienic conditions. Body and environmental areas were sampled and the catalase-positive gram-positive cocci isolated were tested for production of coagulase, deoxyribonuclease, hemolysin, gelatinase, and utilization mannitol. The results show that there were no significant differences in frequency of occurrence of biochemical types among subjects and among environmental areas during the chamber period. There were significant differences in the frequency of occurrence of biochemical types on nose, throat, gingiva, axilla, groin, glans penis, anus, and toe. There was no buildup of biochemical types with time in any test condition. One phage type, 29/UC-18, was recovered and was passed from one subject the environment but not to other subjects. In the concurrent metabolic studies the physiological, biochemical, and nutritional parameters investigated were all in the normal range of clinical values. Confinement under simulated aerospace conditions for at least 28 consecutive days and conditions of minimal personal hygiene show that no unique set of circumstances are operable that would require the establishment of special biomedical criteria. Author (TAB)

N68-20016*# Northrop Corp., Hawthorne, Calif. Corporate Labs.

INVESTIGATION OF PEROGNATHUS AS AN EXPERIMENTAL ORGANISM FOR RESEARCH IN SPACE BIOLOGY Final Report

R. G. Lindberg Feb. 1968 262 p refs

(Contract NASw-812)

(NASA-CR-93832) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Pocket mice (genus *Perognathus*) are proposed as particularly suitable subject matter for space biology research by virtue of their unusual physiology which permits significant simplification of the life support systems in biosatellites. The resultant savings in payload, coupled with the small size of the animals, permits the formulation of experimental designs involving large numbers of mammals, and a significantly higher probability of definitive results from this experimentation. Specific data are presented on the following: breeding, growth and development; thermoregulation; hibernation; circadian periodicity; and radiobiology. From these data are derived: (1) metabolic baselines delimiting the nature and complexity of a life support system for pocket mice in space vehicles; (2) baselines of selected physiological traits of pocket mice that are potentially useful for assessing the biological effects of extraterrestrial residence; and (3) specific design for a space biology experiment utilizing pocket mice to study the stability of circadian systems in space. Author

N68-20022 Illinois Univ., Urbana.

AN INVESTIGATION OF THE EFFECTS OF INTENSE NONCAVITATING ULTRASOUND ON SELECTED ENZYMES

Robert Malcolm MacLeod (Ph.D. Thesis) 1966 122 p

(Contract Nonr-1834(29); Grant NSF GB-2050) Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-6663

Solutions of five enzymes (α-chymotrypsin, trypsin, lactate dehydrogenase, aldolase, and ribonuclease) were irradiated with noncavitating ultrasound under a variety of physical and chemical conditions. Two types of ultrasonic irradiations were performed on the enzyme solutions. In the first type the solutions were exposed to the noncavitating ultrasound and then analyzed to determine if any permanent change in the enzyme molecules was produced. In the second type the enzyme is irradiated in a solution of its substrate, while it is catalyzing a specific biochemical reaction. The results of both types of irradiations show that the noncavitating ultrasound has no effect on either the structure or the function of the enzymes. It is concluded that cavitation is a necessary condition if damage is to be produced by ultrasound in enzyme solutions *in vitro*. Dissert. Abstr.

N68-20026*# National Aeronautics and Space Administration, Washington, D. C.
AEROSPACE MEDICINE AND BIOLOGY—A CONTINUING BIBLIOGRAPHY WITH INDEXES
Feb. 1968 175 p refs
(NASA-SP-7011(47)) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Subject coverage concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. Each entry consists of a standard citation accompanied by its abstract. Author

N68-20027*# National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.
AEROSPACE MEDICINE AND BIOLOGY—A CONTINUING BIBLIOGRAPHY WITH INDEXES
Mar. 1968 131 p refs For abstract see N68-20026 10-04
(NASA-SP-7011(48)) CFSTI: HC $3.00/MF $0.65 CSCL 06S

N68-20060# School of Aerospace Medicine, Brooks AFB, Tex. Aerospace Medical Div.
THE CHANGING PARAMETERS OF THE HABITUATING VESTIBULAR SYSTEM, JUNE 1964–JANUARY 1967
Robert L. Cramer, Patrick J. Dowd, Edwin W. Moore, and Frederick G. Collins Sep. 1967 12 p refs
(SAM-TR-67-85; AD-664898)

Nystagmic responses to a Coriolis stimulation were recorded from a human subject over a period of ten sessions of four stimuli each. The response can be approximated by simple negative exponential growth and decay functions. Repeated exposure results in a reduction of the subjects sensitivity to the stimulus. At the same time the dynamic characteristics of the system mediating the response change so as to provide a more rapid recovery from the stimulus. Both of these changes are beneficial to a pilot, as they improve his resistance to some forms of spatial disorientation. Author (TAB)

N68-20089# University of Southern Calif., Los Angeles.
MODIFICATION OF STRESS RESPONSES TO COLD AND ELECTRIC SHOCK: THE USE OF AUTOHYPNOTIC TECHNIQUES Final Technical Report, 1 Jul. 1965–31 May 1967
Perry London and Ronald A. McDevitt Wright-Patterson AFB AMRL Oct. 1967 131 p refs
(Contract AF 33(615)-2958; Grants NIH 1-K3-MH-31; NIH 1-K3-MG-209-01)
(AMRL-TR-67-142; AD-664940)

This project was undertaken to determine the usefulness of autohypnotic training for overcoming the debilitating effects of stress on performance and physiological processes. The experiment was performed on 64 male volunteers, one-half high in hypnotic susceptibility and one-half low. Each subject then went through three experimental sessions, one without stress and two with stress, in each of which he was given two performance tasks and monitored on eight physiological measures. Cold (35C) and electric shock (15 second average interval) were used as the stressors. After the non-stress and first stress sessions, the subjects in the experimental group received 6 hours of autohypnotic training, oriented toward enabling them to function optimally under stress without excessive discomfort. Author (TAB)

N68-20092*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
GROWTH OF AEROBIC AND ANAEROBIC BACTERIA IN AGAR SUBJECTED TO FREEZING AND DIURNAL FREEZING AND THAWING
R. E. Cameron, G. B. Blank, and N. H. Horowitz 15 Jun. 1967 15 p refs
(Contract NAS7-100)
(NASA-CR-93790; JPL-TM-33-331) CFSTI HC $3.00/MF $0.65 CSCL 06M

Surface soils were collected from nine sites on the premises of the Jet Propulsion Laboratory. All samples were mixed and sieved to provide a composite soil sample. The abundance of aerobic and anaerobic bacteria in the sample was determined in trypticase soy agar plates subjected to temperature conditions of (1) room temperature, +25°C; (2) diurnal freezing, −75°C for 16 hr, and thawing, +25°C for 8 hr; and (3) continuous freezing at −75°C. Following two weeks of incubation at the above temperatures, all sets of agar plates were incubated for an additional two weeks at +25°C. No bacteria grew during continuous freezing at −75°C. Aerobes grew during diurnal freezing and thawing at dilutions of 10^{-3} to 10^{-4}. Anaerobes did not grow during diurnal freezing and thawing. All sets of plates showed growth of aerobes and anaerobes by the end of the final two weeks of incubation at +25°C. The abundance of aerobes was greater than anaerobes, but regardless of the first two weeks of temperature conditions, after the second two weeks of incubation at room temperature, survival rates were comparable for sets of aerobic and anaerobic agar plates. Author

N68-20098 Pennsylvania State Univ., University Park.
MECHANISMS INVOLVED IN THE RADIATION INTERRUPTION OF TRANSCRIPTION
Thomas Francis Barone (Ph.D. Thesis) 1966 68 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-5895

The emphasis of this investigation was to determine whether irradiated medium could be used to measure messenger RNA half-life. The following aspects of the action of ionizing radiation were studied: (1) the effect of irradiation on β-galactosidase expression in the presence of catalase; (2) the effect of irradiated medium on β-galactosidase expression; (3) the effect of irradiated medium on proline and histidine incorporation into protein over the temperature range 10°–40°C; (4) effect of irradiated medium on the proline pool in the cell; (5) effect of irradiated medium on glucose uptake and incorporation; (6) effect of irradiated medium on uracil incorporation. Since the effects of irradiated medium on protein synthesis are largely unknown the following experiments were performed: (1) measurement of the half-lives of tryptophanase and β-galactosidase mRNA by pulsed induction; (2) measurement of the pool of valyl-sRNA after treatment with hydrogen peroxide. Dissert. Abstr.

N68-20120*# Hayes International Corp., Birmingham, Ala.
A STUDY TO DETERMINE THE FEASIBILITY OF USING PHYSICAL METHODS FOR BIOCHEMICAL ANALYSIS UNDER SPACE FLIGHT CONDITIONS Final Report, 16 Jan.–16 Sep. 1967

16 Sep. 1967 196 p refs
(Contract NASw-1560)
(NASA-CR-93831; Rept.-1428) CFSTI: HC $3.00/MF $0.65 CSCL 06A

The study was initiated with literature searches, both computerized and manual, culminating in a massive search of *Chemical Abstracts* for the period from 1906 through 1966. The result is a comprehensive survey of analytical techniques and methodology, effectively defining the present state of the art relative to the biochemical constituents included in this study. The review of each constituent is complete in itself, including a merit evaluation of analytical methods with effective figures of merit and an annotated bibliography. This information is presented in summary form in a table. A concerted attempt was made to find or propose new physical methods and techniques of analysis. Three new analytical methods are presented. Recommendations concerning the further development of methodologies are offered. Author

N68-20151*# National Academy of Sciences—National Research Council, Washington, D. C.
PHYSIOLOGY IN THE SPACE ENVIRONMENT. VOLUME 2: RESPIRATION
1967 147 p refs Conf. held by NAS-NRC, Woods Hole, Mass., Jun.–Jul. 1966
(Contract NSR-09-012-036)
(NASA-CR-93455; Publ.-1485-B, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 06S

CONTENTS:

1. INTRODUCTION, SUMMARY AND RECOMMENDATIONS R. E. Forster p 3–18 (See N68-20152 10-04)

2. STRUCTURAL CHANGES IN LUNG AND THORAX N. C. Staub p 21–25 refs (See N68-20153 10-04)

3. RESPIRATORY MECHANICS J. Mead p 26–30 refs (See N68-20154 10-04)

4. PULMONARY GASEOUS DIFFUSION N. C. Staub p 31–37 refs (See N68-20155 10-04)

5. PULMONARY CIRCULATION AND THE DISTRIBUTION OF BLOOD AND GAS IN THE LUNGS S. Permutt p 38–56 refs (See N68-20156 10-04)

6. REGULATION OF BREATHING J. Mead p 57–58 ref (See N68-20157 10-04)

7. EXCHANGE OF FLUIDS IN LUNGS A. B. Du Bois p 59–65 refs (See N68-20158 10-04)

8. RESPIRATORY TRACT CLEARANCE MECHANISMS FOR NONGASEOUS MATERIALS P. E. Morrow p 66–78 refs (See N68-20159 10-04)

9. DIFFUSION OF GASES IN PERIPHERAL TISSUE K. L. Zierler p 79–86 refs (See N68-20160 10-04)

10. TEMPERATURE REGULATION D. Minard p 87–90 refs (See N68-20161 10-04)

11. OXYGEN TOXICITY AT NEAR-NORMAL PARTIAL PRESSURES R. E. Davies p 93–98 refs (See N68-20162 10-04)

12. CONSIDERATIONS OF CARBON DIOXIDE CONCENTRATION R. E. Forster p 99–101 refs (See N68-20163 10-04)

13. INERT GASES W. O. Fenn p 102–112 refs (See N68-20164 10-04)

14. TRACE CONTAMINANTS J. C. Ross p 113–122 refs (See N68-20165 10-04)

15. PARTICULATE MATTER: GENERAL CONSIDERATIONS AND AEROSOL DEPOSITION IN MAN P. E. Morrow p 123–130 refs (See N68-20166 10-04)

16. INFECTION J. C. Ross p 133–142 refs (See N68-20167 10-04)

17. RESPIRATORY DRUGS AND MANNED SPACE FLIGHT P. E. Morrow p 143–148 refs (See N68-20168 10-04)

N68-20152*# National Academy of Sciences—National Research Council, Washington, D. C.
INTRODUCTION, SUMMARY AND RECOMMENDATIONS
Robert E. Forster *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 3–18 (See N68-20151 10-04)

An overview is presented on respiratory physiology and relevant medical problems, with attention directed to the problems introduced by the artificial environment and other supportive mechanisms necessary for maintaining a man in space. Summaries and research recommendations are included on the major topics of lung functions, the atmosphere, and lung infection and treatment. Consideration was also given to bioinstrumentation requirements. These include: (1) An instrument to measure inspired and expired gas volumes such as a waterless spirometer to be connected to the airway. (2) A method for measuring lung volume changes while performing work free in the cabin, and when in the pressure suit, without obstructing the mouth. (3) An instrument to measure the number and size of particles suspended in the air, including the full range of sizes that might be deposited in the lung, and similarly to monitor the particles in the inspired and expired breath. (4) Methods of estimating the capillary blood flow in the periphery, and the peripheral oxygen tension. M.G.J.

N68-20153*# National Academy of Sciences—National Research Council, Washington, D. C.
STRUCTURAL CHANGES IN LUNG AND THORAX
Norman C. Staub *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 21–25 refs (See N68-20151 10-04)

While there is no apparent reason to expect prolonged space flight to cause changes in primary lung structure, general deconditioning of the body could extend to the thoracic cage and muscles, altering the mechanics of ventilation. Such factors as radiation, inhalation of particulates and contaminants, and possible tissue damage resulting from higher than normal P_{O_2} could lead to cellular changes in the lungs. It is recommended: (1) Quantitative histological techniques should be applied to the lung to determine changes of its cellular structure. (2) The effects of acceleration deformation and damage should be studied, with the use of rapid freezing techniques. (3) Functional, structural, and chemical analyses of the lungs should be made on animals exposed to various patterns of simulated space radiation. Author

N68-20154*# National Academy of Sciences—National Research Council, Washington, D. C.
RESPIRATORY MECHANICS
Jere Mead *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 26–30 refs (See N68-20151 10-04)

Data show that sufficient acceleration will limit or prevent lung movements during launch, but such periods will probably not exceed the limits of breath holding. The mechanical strength of the lung may place a limit on the accelerative forces to which the human body can safely be subjected. Probably the pulmonary blood vessels would rupture before the parenchyma tore. During zero G, changes in lung mechanics would be minimal. One would predict a decrease of about 20% in end-expiratory lung volume and a resulting small decrease in airway conductance. Inspiration of particulate matter might be more common, in which case the cough mechanism is more important. On theoretical grounds, the air velocity with a cough would probably be greater, but the decreased density of the gas might make the cough less effective. Research recommendations are presented. Author

N68-20155*# National Academy of Sciences—National Research Council, Washington, D. C.
PULMONARY GASEOUS DIFFUSION
Norman C. Staub *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 31–37 refs (See N68-20151 10-04)

It is shown that there is no reason to suppose that gaseous diffusion processes will be affected by zero G, unless the lung parenchyma sustains chronic or acute damage secondary to accelerations at launch or reentry. It is recommended that the pulmonary diffusion capacity should be investigated as a general test of lung function in space flight. It should give a convenient estimate of changes in the lung that might make reentry dangerous, such as those secondary to toxic contaminants in the cabin atmosphere, parenchymal changes due to increased oxygen tension, and changes in the pulmonary vasculature secondary to weightlessness. Author

N68-20156*# National Academy of Sciences—National Research Council, Washington, D. C.

PULMONARY CIRCULATION AND THE DISTRIBUTION OF BLOOD AND GAS IN THE LUNGS

Solbert Permutt *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 38–56 refs (See N68-20151 10-04)

Although prolonged space travel appears to offer no significant problems in this respect, the relations between blood flow and ventilation are likely to be optimal in the weightless state. Acceleration may produce adverse effects, however, and it is important to be able to evaluate risks and the physiological tolerances involved. Basic knowledge is needed concerning the effect of acceleration on the blood volume and capacitance of the systemic circulation, and of changes of volume in the vascular structures of the thorax presumably caused by reflex and hormonal mechanisms. The effects of gravity are so profound in altering the distribution of blood and gas within the lungs that many problems in basic pulmonary physiology can be studied more effectively under weightlessness than in a normal gravitational field. One of the dividends of space flight will be the opportunity to carry out experiments on the lungs that are impossible on earth. Author

N68-20157*# National Academy of Sciences—National Research Council, Washington, D. C.

REGULATION OF BREATHING

Jere Mead *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 57–58 ref (See N68-20151 10-04)

The slight alterations in pulmonary mechanics to be expected under zero G and possible deviations in inspired oxygen and carbon dioxide, depending on the composition of the cabin atmosphere, could affect the level of ventilation through well-known mechanisms. Current knowledge indicates that these effects would be too small to be physiologically significant. Minute volume tends to decrease during acceleration even to the point of apnea, but as long as its duration is brief no more serious stress than that of ordinary breath holding would exist. Hyperventilation can occur under stress, but it is not a problem unique to space flight. Recommendations include: (1) Minute ventilation during increased G at launch and reentry and during weightlessness should be monitored both during exercise and at rest. (2) The ventilatory response to exercise and to hyperoxia, particularly in the capsule and in the space suit, should be monitored under chronic conditions. Author

N68-20158*# National Academy of Sciences—National Research Council, Washington, D. C.

EXCHANGE OF FLUIDS IN LUNGS

Arthur B. du Bois *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 59–65 refs (See N68-20151 10-04)

Data are presented to show that fluid which enters the lungs through aspiration of secretions or by transudation from the lung capillaries would normally be removed by the various lung-clearing mechanisms, which should operate sufficiently well in space flight. Intentional filling of the lungs or pleural space with liquid to support the pulmonary blood vessels and lung parenchymal tissues during accelerations greater than 15 G may be tried experimentally in anticipation of life support systems for flights far in the future and for the reentry phase of the flight. Recommendations for research include: (1) Measurements should be made of those pressures related to filtration of fluid in the lungs. (2) Arterial oxygen saturation and pressure-volume curve of the lungs should be investigated as indicators of filtration into the tissue. Author

N68-20159*# National Academy of Sciences—National Research Council, Washington, D. C.

RESPIRATORY TRACT CLEARANCE MECHANISMS FOR NONGASEOUS MATERIALS

Paul E. Morrow *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 66–78 refs (See N68-20151 10-04)

Three physiological mechanisms are identified for keeping the epithelial surfaces of the respiratory tract relatively free of contaminants: (1) ciliary mucous transport, (2) endocytosis, and (3) lymphatic drainage. Ciliary mucous transport may be affected, probably slightly, by gravity and may also be influenced by the high concentration of ions presumed to exist in space capsules. In vitro and in vivo preparations exist for study of mucous transport and should be employed to test responses under appropriate conditions. There is no evidence that endocytosis is influenced by gravity, but on the other hand there is insufficient data on endocytosis in mammals. It is recommended: (1) Mucous clearance and sinus drainage as a function of posture, humidity, and drugs at 1 G, zero G, and increased G should be studied. (2) Ciliary preparations (animal trachea) should be used as one means of studying the toxicology of contaminants. Author

N68-20160*# National Academy of Sciences—National Research Council, Washington, D. C.

DIFFUSION OF GASES IN PERIPHERAL TISSUE

Kenneth L. Zierler *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 79–86 refs (See N68-20151 10-04)

If translocation of O_2 within tissues is, as the evidence suggests, caused purely by diffusion driven by gradients in P_{O_2}, the gravitational field or lack of it should not have any important effect on the diffusion coefficient or on diffusion itself. To insure adequate delivery of O_2 to the tissues, arterial capillary P_{O_2} should be maintained at the normal value at sea level. Given this condition, adequate oxygenation of tissues will depend on functional capillary blood flow, which determines the volume of tissue supplied by each capillary. The distribution of functional capillary blood flow conceivably can be affected by variations in and lack of gravity. Recommendations include: (1) Methods should be applied to assess tissue hypoxia in intact man, including measurement of chemicals in the blood. (2) Methods for monitoring tissue oxygen tension directly should be investigated. (3) Distribution of peripheral capillary blood flow under flight conditions should be investigated. Author

N68-20161*# National Academy of Sciences—National Research Council, Washington, D. C.

TEMPERATURE REGULATION

David Minard *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 87–90 refs (See N68-20151 10-04)

It is not anticipated that the role of the respiratory system as a heat exchanger will be significantly altered during space travel. If the space cabin atmosphere has a lower total pressure or uses helium as an inert gas, the decreased air density will cause a slight and physiologically insignificant decrease in body heat lost to the inspired air. Except for the possibility of heat hyperpnea under unusual or emergency situations, heat loads encountered in space travel should have minor influence on the level of minute ventilation. The possibility of untoward temperature regulation resulting from altered circulation in the weightless state is conceivable but on the basis of present knowledge is unlikely. Recommendations include: (1) The rate of evaporation from the respiratory tract at zero G should be studied. (2) The nature of heat hyperpnea should be elucidated to determine whether it is adaptive to heat exposure. Author

N68-20162*# National Academy of Sciences—National Research Council, Washington, D. C.

OXYGEN TOXICITY AT NEAR-NORMAL PARTIAL PRESSURES

Robert E. Davies *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 93–98 refs (See N68-20151 10-04)

The basic metabolic defect associated with the physiological changes caused by O_2 toxicity are still unknown. It is pointed out that the literature fails to demonstrate that increased inspired P_{O_2} (at least to 5 psi) is safe for prolonged use by man. Further testing for long periods with human subjects is essential before such a conclusion can be drawn. Normal (sea level) partial pressures of inspired O_2 are known to be acceptable. Reduced partial pressures may also be acceptable, and sometimes unavoidable, but the conditions and limits have yet to be pinpointed. Research recommendations include: (1) A normal inspired oxygen tension, as contrasted with an elevated inspired oxygen tension, is recommended. (2) The advantages and disadvantages of an inspired P_{O_2} less than and greater than, normal sea level should be investigated for times adequate to demonstrate a steady-state response. (3) Cabin P_{O_2} and total pressure should be monitored for a mixed gas environment. Author

N68-20163*# National Academy of Sciences—National Research Council, Washington, D. C.

CONSIDERATIONS OF CARBON DIOXIDE CONCENTRATION

Robert E. Forster *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 99–101 refs (See N68-20151 10-04)

Ideally, from the physiological point of view, it would be best to keep inspired P_{CO_2} close to zero, as it is under normal sea-level conditions. In the manned space flights to date the circulating atmospheric P_{CO_2} has apparently been kept to less than 7.6 torr, although this may be because of engineering (thermal exchange) rather than physiological considerations. A maximum limit of 7.6 torr was chosen because chronic exposure to CO_2 concentrations just above that limit has demonstrated adaptive changes. The effect of chronic exposure to low inspired concentrations of CO_2 should be explored. Furthermore, a time-concentration-response curve to CO_2 exposure should be obtained to guide procedure in the event that the CO_2-removing equipment fails. Author

N68-20164*# National Academy of Sciences—National Research Council, Washington, D. C.

INERT GASES

Wallace O. Fenn *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 102–112 refs (See N68-20151 10-04)

Advantages of adding an inert gas or gases to the space cabin atmosphere are cited as (1) fire danger is reduced; (2) aural and pulmonary atelectasis is inhibited; (3) there is a possible, but unproved, long-term physiological need for at least low pressures of nitrogen; and (4) ventilation and heat dissipation within the cabin may require a total gas pressure greater than the ceiling recommended for cabin P_{O_2}. The only physiological disadvantage is the risk of the gas's producing the bends. There may be engineering disadvantages in that a double monitoring system is required and, depending on cabin leakage, there will be the extra cost of carrying a supply of inert gas. With a possible exception if absolute lack of nitrogen for long periods proves deleterious, a deficit not overcome by helium, there is little to choose between nitrogen and helium. It was concluded that some inert gas should be added, at least until an effective method of controlling fires in 100 percent oxygen becomes available. A pressure of 2 or 3 psia (assuming total pressure remains at 5 psia) is suggested as a reasonable concentration. Further research is suggested. Author

N68-20165*# National Academy of Sciences—National Research Council, Washington, D. C.

TRACE CONTAMINANTS

Joseph C. Ross *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 113–122 refs (See N68-20151 10-04)

Because the capsule gas is recycled, contaminants that are normally present in only negligible amounts may increase to toxic levels and may concentrate on airborne particulate matter, which in turn will be increased in the absence of the sedimentation process. All the existing and possible atmospheric contaminants in the spaced capsule, including gases, particles, and infectious agents, have not been identified, nor have their effective concentrations been determined. These contaminants should be monitored and regulated, preflight and in-flight (manned), with particular attention to contaminants produced by fire or unusual heat in the vehicle. The threshold limit value of tolerance to various contaminants should be determined for continuous exposure, as contrasted with the more usual intermittent exposure, and the possibly additive effect of stress and infection should be included. Author

N68-20166*# National Academy of Sciences—National Research Council, Washington, D. C.

PARTICULATE MATTER: GENERAL CONSIDERATIONS AND AEROSOL DEPOSITION IN MAN

Paul E. Morrow *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 123–130 refs (See N68-20151 10-04)

In zero G at hypobaric pressure, airborne stability of dusts will be affected by inertial impaction (large particles), by diffusion or deposition by Brownian motion (smallest particles), but not by sedimentation. Interception of fibers (small diameter, great length) may increase in the bronchial tree. A different distribution of aerosol deposition in the respiratory tract is thus anticipated with respect both to particle size and to site. This has important implications for production of pulmonary disability. It is recommended that studies of aerosol composition (size and association of contaminants with various particle sizes) be instituted. Moreover, tests should be made in simulated respiratory tracts to determine the size and site of deposition of aerosols under flight conditions. Additional studies of aerosol-removal methods are also indicated. Author

N68-20167*# National Academy of Sciences—National Research Council, Washington, D. C.

INFECTION

Joseph C. Ross *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 133–142 refs (See N68-20151 10-04)

The likelihood of microbial infections increases with (1) the size of the space crew; (2) less than ideal facilities for personal hygiene over long periods; (3) possibly altered viability of microorganisms, autoflora, and mechanisms of challenge; and (4) individual susceptibility associated with the space cabin environment. It is recommended that the microbial content of the space vehicle be controlled, that consideration be given to selection of space crews on the basis of similar immunological patterns (including cross matching for blood types), and that crews be isolated as a group before the flight both to prevent exposure to infection and to allow cross-immunity to develop. Author

N68-20168*# National Academy of Sciences—National Research Council, Washington, D. C.

RESPIRATORY DRUGS AND MANNED SPACE FLIGHT

Paul E. Morrow *In its* Physiol. in the Space Environment. Vol. 2: Respiration 1967 p 143–148 refs (See N68-20151 10-04)

Space flight conditions may lead to nasal congestion, obstructed sinuses, and the like, and to the increased possibility of inhaling food and large particles. Decongestants and dilators would probably be needed in such instances. Pulmonary infection would require a battery of therapeutic agents similar to those used at sea

level. Otherwise, there appear to be no specific considerations peculiar to space flight. A critical review of possible problems and of the methods by which drugs have been selected, tested, and dispensed, indicates that the subject needs thorough study and, possibly, continuing evaluation by an advisory board. Author

N68-20183*# School of Aerospace Medicine, Brooks AFB, Tex.
CARBON DIOXIDE TOLERANCE STUDIES
H. A. Glatte, Jr., G. J. Motsay, and B. E. Welch Sep. 1967 29 p refs
(NASA Order T-41829-G)
(NASA-CR-93751; SAM-TR-67-77; AD-664899) CFSTI: HC $3.00/MF $0.65 CSCL 06P

Seven normal volunteers were exposed to an environment of 21 mm. Hg CO2 (3%) for a 5-day experimental period bracketed by two 5-day control periods. Measurements included daily serum and urine electrolytes, blood gas studies, and net acid excretion studies. Also included were detailed investigations of respiratory physiology, exercise response, and psychomotor performance. All subjects tolerated the experimental atmosphere with no undue problems. Arterial and alveolar PCO2s increased 3 to 4 mm. Hg with a mild reduction in arterial pH from 7.40 to 7.37. Arterial pH values returned to near control values by the fourth day. No increases were noted in net acid excretion. Exercise was tolerated remarkably well. Author (TAB)

N68-20190 California Univ., Berkeley.
DIFFUSION OF OXYGEN IN PROTEIN SOLUTIONS
Thomas Karl Goldstick (Ph.D. Thesis) 1966 185 p
Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-5061

To improve the understanding of oxygen transport in biological fluids, the oxygen diffusion coefficient, D, was determined in two protein solutions and one salt solution, over the complete range of solute concentrations. The two proteins studied were bovine serum albumin and human oxyhemoglobin, the salt was KCl. To determine D, the oxygen tension at the bottom of a layer of solution is continuously recorded after changing the tension at the top. A mathematical analysis of the transient curve gives D. This method requires neither solubility data nor empirical constants. The experimental results give a value for D in water at 25°C of 2.13×10^{-5} cm^2/sec. The studies on solutions show that solutes tend to lower D. Both albumin and hemoglobin appear to lower D by similar amounts, but KCl has much less effect. A value of 0.78×10^{-5} cm^2/sec is indicated for D at the hemoglobin concentration in normal red cells. Dissert. Abstr.

N68-20208# School of Aerospace Medicine, Brooks AFB, Tex.
ADRENOCORTICAL STEROIDS, BODY ORGAN WEIGHTS, AND HEMATOLOGY OF RATS EXPOSED TO A PURE OXYGEN ENVIRONMENT AT 210 MM HG, ABSOLUTE Research Report, Sep. 1965–Jan. 1967
William E. Pepelko Sep. 1967 18 p refs
(SAM-TR-67-78; AD-664897)

Continuing interest in the possible use of low pressure, normoxic environments in spacecraft has led to investigation of the effect of such environments upon hematologic parameters, organ weights, and plasma corticosteroids. Experiments were conducted with rats exposed up to 11 months in an environment containing 98% oxygen at 210 mm. Hg, absolute. Blood levels of corticosterone and body and organ weights of experimental animals were measured after specified periods of exposure. Hematologic parameters (hematocrit, hemoglobin, red cell, white cell, eosinophil, and reticulocyte counts) were also determined. Except for the first few days of exposure to altitude, the results of plasma corticosterone determinations gave no evidence of prolonged stress to the animals. In general, changes in body organ weights and hematologic parameters were minor and did not appear to affect the animals adversely even after 11 months of continuous exposure. Author (TAB)

N68-20238 Oregon State Univ., Corvallis.
EFFECTS OF VARIATIONS IN SALINITY AND TEMPERATURE ON SOME ESTUARINE MACRO-ALGAE
Chris Kelvin Kjeldsen (Ph.D. Thesis) 1967 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-5654

Eight species, *Ulva expansa, Enteromorpha linza, Laminaria saccharina, Sargassum muticum, Alaria marginata, Odonthalia floccosa, Iridaea splendens* and *Gigartina californica*, were used in laboratory studies to determine the effect of variations in temperature and salinity on rates of respiration and photosynthesis, thus determining the control these ecological factors may exert in nature. A series of experiments were also undertaken to determine the effect of adaptive exposure upon the metabolic rates of macro-algae in media of various salinities. *Ulva expansa, Laminaria saccharina, Sargassum muticum, Alaria marginata,* and *Gigartina californica* showed tolerances to variations in salinity and temperature in laboratory experiments correlating with their distribution in the estuary, and with its physical-chemical regime. In laboratory experiments, *Enteromorpha linza, Odonthalia floccosa,* and *Iridaea splendens* showed tolerance to variations of salinity and temperature exceeding the variations they encountered in nature and therefore, their distribution must be limited by some other factors. Dissert. Abstr.

N68-20250# School of Aerospace Medicine, Brooks AFB, Tex. Biosciences Branch.
EFFECTS OF MONOMETHYLHYDRAZINE ON LIVER GLYCOGEN CONTENT OF RATS AT GROUND LEVEL AND AT ALTITUDE, SEPTEMBER 1965–JANUARY 1966
Lawrence E. Brown and Walter N. Scott Sep. 1967 16 p refs
(SAM-TR-67-79; AD-664900)

Histologic sections of liver samples taken at altitude and ground level from rats having received monomethylhydrazine (MMH), 46.4 mg./kg., were stained for glycogen. Results revealed that nonfasted MMH-injected animals maintained at altitude (18,000 ft.) contained a decreased content of intracellular liver glycogen. The livers of nonfasted rats injected at ground level did not manifest changes in glycogen content. The hepatic glycogen content of the fasted MMH-injected rats (both ground level and altitude) did not differ from that of the controls. Chemical analyses revealed a decrease in hepatic glycogen in rats fed at altitude and an increase in rats fasted at altitude. Author (TAB)

N68-20258 California Univ., Los Angeles.
ELECTROPHYSIOLOGICAL CORRELATES OF PERCEPTUAL MASKING IN MONKEYS
Lester George Fehmi (Ph.D. Thesis) 1966 196 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-6176

Retroactive perceptual masking is well documented in human subjects when a brief flash of light containing a figure to be perceived is followed closely by a second flash, perception of the figure is masked. Such masking has been interpreted as due to interactions occurring peripherally (within the eye), centrally visual pathways and cortex), or to a combination of peripheral and central factors. This study has sought to investigate experimentally the nature and locus of the masking effect. Perceptual masking has been produced in monkeys, using a trained behavioral response as an index of masking. Electrical potentials were recorded simultaneously from optic nerve or tract, lateral geniculate body and visual cortex. These electrical responses were correlated with the monkey's ability to make a correct behavioral response. Dissert. Abstr.

N68-20346*# Northrop Corp., Hawthorne, Calif.
FEASIBILITY STUDY FOR CONDUCTING BIOLOGICAL EXPERIMENTS ABOARD A PIONEER SPACECRAFT
Robert G. Lindberg, ed. Feb. 1968 250 p
(Contract NAS2-4491)
(NASA-CR-73178; NCL-68-10R) CFSTI: HC $3.00/MF $0.65 CSCL 06C

A study was conducted to determine the feasibility and practicality of conducting biological experiments aboard a Pioneer spacecraft in heliocentric orbit. Among the biological problems amenable to study on such a vehicle is the question of the stability of circadian systems divorced from geophysical cues. The study included experiment definition; conceptual design of experiment hardware; where necessary, studies of the susceptibility of biological material to simulated launch stresses; identification of requirements for monitoring devices to characterize the physical environment during biological experimentation; cost and development schedule estimates for individual experiments; and selection of representative combinations of biological and physical sciences payloads. The study was specifically directed toward engineering feasibility. The results of the study demonstrated the practicality of implementing biological experiments aboard a Pioneer spacecraft and recommend a follow-on study for program definition preparatory to initiation of a BioPioneer Program. Author

N68-20385# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
BIOLOGY
In its Space Res. Direc. for the Future 1966 p 477–500 refs
(See N68-20376 10-30)

Recommendations are made for further research in the areas of environmental biology; exobiology; the role of man in space in broad programs of environmental space biology and planetary exploration; and specific NASA structures, practices, and policies that pertain to support of fundamental biological objectives. Three fields of basic biological research are singled out as candidates for benefiting by exploitation of conditions and facilities for experimentation that are only available in space. These are: radiation biology, studies of circadian rhythms, and investigations of gravitational influences in the range of G values between zero and 1. The NASA Biosatellite Program and a similar U. S. Air Force program are reviewed. M.G.J.

N68-20386# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
MEDICINE AND PHYSIOLOGY
In its Space Res. Direc. for the Future 1966 p 501–621 refs
(See N68-20376 10-30)

Medical and behavioral findings from the United States and Soviet manned space flights are reviewed, and the available information from ground-based and aircraft experience is appraised. Gaps in biomedical knowledge that could affect the progress of the manned program are identified. The manned and unmanned programs studied include Gemini, Apollo, Apollo Applications Program, U. S. Air Force Manned Orbiting Laboratory, biosatellites, and ground-based research. Man's scientific role in space missions is evaluated, with emphasis on the biomedical investigations that he may perform in space. Biomedical experiments planned for the manned space flight program are listed, along with scheduled biosatellite experiments. Capabilities and requirements for manned planetary missions are defined. A status-of-knowledge review on weightlessness (1965) is presented, along with an assessment of needed experimental work on circulation and respiration, and metabolism and nutrition. M.G.J.

N68-20408# Association Francaise pour l'Etude et le Development des Applications de l'Energie Solaire, Paris.
UTILIZATION OF SOLAR ENERGY BY PLANTS. MEASUREMENT OF SOLAR RADIATION AND YIELD OF PHOTOSYNTHESIS [L'UTILISATION DE L'ENERGIE SOLAIRE PAR LES VEGETAUX. MESURE DU RAYONNEMENT SOLAIRE ET DU RENDEMENT DE LA PHOTOSYNTHESE]
1967 70 p refs In FRENCH Symp. held in Paris, 28 Sep. 1967
CFSTI: HC $3.00/MF $0.65

Instruments and methods for measurement of terrestrial radiation are discussed. The report concludes with measurement of photosynthetic activity per area unit of leaves. ESRO

N68-20451# Naval Radiological Defense Lab., San Francisco, Calif.
AN IMMEDIATE IRRADIATION EFFECT ON RESISTANCE OF RATS TO LOW TEMPERATURE
Richard D. Phillips and Donald J. Kimeldorf 4 Jan. 1968 22 p refs
(USNRDL-TR-68-6; AD-665664)

A study was made of the effect of whole-body X-irradiation (50-2000 rads) on the resistance of male rats exposed to a low environmental temperature (-17.0 plus or minus 1C). The animals were subjected to the test environment at 1/2, 4, 8, 16, or 24 hours after irradiation. A change in resistance was observed after irradiation with doses of 100 rads or more. Irradiation had a detrimental effect on the survival of rats exposed to low temperature at all times tested. The radiation-induced decrease in cold resistance was greater in groups tested early after irradiation than in groups tested at 16 or 24 hours postirradiation. The magnitude of the radiation effect was dose dependent. At doses greater than 100 rads, the median survival time of rats in the cold was inversely related to radiation dose. Author (TAB)

N68-20457# Naval Air Development Center, Johnsville, Pa.
AN INVESTIGATION OF THE EFFECTS OF ISOLATION ON TIME PERCEPTION AND ITS PHYSIOLOGICAL CORRELATES
Barry K. Schwartz 9 Nov. 1967 94 p refs
(NADC-MR-6718; AD-665517)

A review of the literature on physiological correlates of time perception, the effects of drugs on time perception, and changes in time perception due to sensory deprivation indicated that: (a) time perception is quite possibly a physiologically controlled phenomenon, (b) that body temperature, and possibly heart and respiratory rate, are indicators of the course of changes in time perception, and that (c) sensory deprivation may induce errors in time perception, the direction of which errors is apparently related to activation level--a function of severity of isolation. Twenty Ss were confined for three hours in an extremely restricting isolation environment. Severity of isolation was manipulated by the introduction of auditory and/or visual stimulation. Ss task was to produce intervals of 1, 5, 15, and 30 seconds duration before and during isolation. Heart rate, respiratory rate, axillary body temperature, and skin temperature were recorded immediately before each trial. Heart and respiratory rate were clearly uncorrelated with time production errors. Axillary temperature and skin temperature were not clearly related or unrelated to time production errors. The time production data indicated differences in length of interval to be produced interacting with the presence or absence of auditory stimulation. The physiological data indicated that amount of time in isolation affected activation differentially for Ss with and without stimulation. Without visual stimulation, activation tended to increase slightly over time. With visual stimulation, there was a slight decrease in activation over time. Author (TAB)

N68-20471# School of Aerospace Medicine, Brooks AFB, Tex.
EFFECTS OF HIGH ACCELERATION ON VESTIBULO-OCULAR RESPONSES, AUGUST 1966–JUNE 1967

Patrick J. Dowd, Morgan E. Wing, Robert L. Cramer, and Frederick G. Collins Sep. 1967 14 p refs
(SAM-TR-67-93; AD-665413)

Preliminary investigations into the effects of high linear accelerations on the vestibulo-ocular responses to both caloric and Coriolis stimulations were made. Pilots were subjected to short-duration accelerations on the USAF School of Aerospace Medicine centrifuge. A spontaneous slow-phase downward nystagmus was observed in some pilots in post-centrifuge tests. Some peripheral and central-neural modification resulting from centrifugation was observed. Author (TAB)

N68-20480*# Northrop Space Labs., Hawthorne, Calif.
DETERMINATION OF APOLLO EMERGENCY IMPACT LIMITS
C. F. Lombard, S. H. Advani, A. Roy, and M. S. Estes [1968] 122 p refs
(Contract NAS9-4539)
(NASA-CR-92039; NSL-65-179) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Pathophysiological responses by guinea pigs and monkeys to tailward acting impact accelerations were studied to develop a theoretical model of the mechanisms of injury to the heart and large vessels exposed to such impact forces. The theoretical analog is described by a modified van der Pol equation, and subsystem study of aorta dynamics furnished data on cardiovascular system responses to the accelerations. Use of bradycardia as a symptom of pending injury with increased acceleration is not considered feasible for the two species tested; this symptom occurred too early in the guinea pig and too late in the monkey. Rupture of the heart and great vessels did not occur as predicted because of compensatory pressure in the thoracic cavity, although lacerations of some pulmonary vessels occurred at very high G levels. At levels of 300 G with velocity change of 60 ft/sec, the subjects were dazed but not unconscious. It is believed that, with a proper support/restraint system, man can survive with recoverable injuries at approximately 100 G with such velocity changes. M.W.R.

N68-20543# School of Aerospace Medicine, Brooks AFB, Tex.
ABDOMINAL GAS VOLUME AT ALTITUDE AND AT GROUND LEVEL
Alan J. Greenwald, Thomas H. Allen, and Richard W. Bancroft Nov. 1967 16 p refs
(SAM-TR-67-102; AD-665848)

The effect of decreasing pressure on abdominal gas volume in eighteen young military men was studied under simulated flight conditions and using a displacement volumeter. Studies showed that decompression causes the abdomen to expand but that relatively slight increase in intra-abdominal pressure occurs. Young military men at ground level ordinarily average 0.111 liter (BTPS) of abdominal gas--a statistically significant amount. This amount, in turn, is significantly less than the mean 0.218 liter (BTPS) occurring in subjects when a water-filled naso-gastric catheter connected to a pressure transducer was used. Expansion of the 0.104 liter of dry gases, with concomitant wetting, resulted in 0.500 liter (BTPS) of abdominal gas at an ambient pressure of 230 torr (29,600 ft. pressure:altitude). At this point, 50% of the subjects would be expected to report symptoms of abdominal fullness. At yet lower pressures, subjects reported pain in 6 among 36 man-flights, and at this time the average abdominal gas volume was computed to be 1.09 liters (BTPS). Author (TAB)

N68-20545# School of Aerospace Medicine, Brooks AFB, Tex.
LECTURES IN AEROSPACE MEDICINE, SIXTH SERIES
1967 570 p refs Lectures held at Brooks AFB, Tex., 5–9 Feb. 1967
(AD-665107)

A collection of lectures is presented on aerospace medicine with emphasis placed on problems of manned orbital and interplanetary space flight; human body reactions to weightlessness, acceleration, immobilization, cabin atmosphere, and stress situations during space flight simulation studies are evaluated. For individual titles, see N68-20545 through N68-20574.

N68-20547# School of Aerospace Medicine, Brooks AFB, Tex.
PRE-GEMINI MEDICAL PREDICTIONS VERSUS GEMINI FLIGHT RESULTS
Charles A. Berry and A. D. Catterson *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 28–61 (See N68-20545 10-04)

The Mercury and Gemini space flights provided approximately 2000 man-hours of weightless exposure for evaluating predicted effects of space flight versus actual findings. In general, the environmental hazards and the effects on the man appear to be of less magnitude than originally anticipated. The principal physiologic changes noted were orthostatism for some 50 hours postflight as measured with a tilt table, reduced red cell mass (5 to 20 percent), and reduced X-ray density (calcium) in the os calcis and the small finger. No abnormal psychological reactions have been observed, and no vestibular disturbances have occurred that were related to flight. Drugs have been prescribed for inflight use. The role of the physician in supporting normal space flight is complex, requiring the practice of clinical medicine, research, and diplomacy. Although much remains to be learned, it appears that if man is properly supported, his limitations will not be a barrier to the exploration of the universe. Author

N68-20549# School of Aerospace Medicine, Brooks AFB, Tex.
A STUDY OF HIGH ALTITUDE DECOMPRESSION
Alfred G. Koestler, Martin L. Reite, and Clyde H. Kratochvil *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 77–98 refs (See N68-20545 10-04)

Seventeen chimpanzees were decompressed in 18 separate tests from 179 mm. Hg (breathing 100 percent oxygen) to less than 2 mm. Hg in 0.8 seconds and remained at this altitude from 5 to 210 seconds. After recompression with 100 percent oxygen to 179 mm. Hg, the subjects were maintained at this pressure environment for 4 to 24 hours post decompression. Results of these tests, have established and substantiated the fact that chimpanzees can survive sudden exposure to a near vacuum and recover within 4 hours to once again satisfactorily perform complex behavioral schedules on which they have had extensive training. EKG, respiration, and skin temperature were recorded as standard procedure from all subjects, some of which were instrumented for EEG. All subjects demonstrated tachycardia immediately following decompression which was regularly followed by a rather sudden bradycardia. There was an initial drop in skin temperature immediately after decompression with an ensuing gradual fall resulting in a total decrease of 1.7 to 2.0°C. Visual inspection of the EEG as well as power spectral density computer analysis indicated the expected greater subcortical resistance to anoxia when compared to cortical responses. Author

N68-20550# School of Aerospace Medicine, Brooks AFB, Tex.
LEX COSMICA
William R. Rule *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 99–109 refs (See N68-20545 10-26)

Projected is the creation of codes of law, both Civil and Criminal, concerning the conduct of man and his interrelationships on celestial bodies as well as the enforcement of such codes by an international police and international courts. The underlying principle is that no one nation will reign over specific celestial bodies and that the use of outer space is open to all nations of the world. G.G.

N68-20551# School of Aerospace Medicine, Brooks AFB, Tex.
NONPATHOLOGIC HYPERCAPNIA IN MAN
H. Glatte, B. O. Hartman, and B. E. Welch *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 110–128 refs (See N68-20545 10-04)

By our studies we have clarified some of the effects of hypercapnia on the physiology and performance of normal man. It seems apparent that man can adapt to 3% and 4% carbon dioxide in the atmosphere. At these levels, we were not able to document any state of prolonged acidosis. Indeed, adaptive mechanisms returned the extracellular pH to quite near control values, as was predicted by earlier animal studies. This was achieved without increasing net renal acid excretion. No biphasic swings of euphoria and depression were noted over the five-day period. There were no undue problems with discomfort from the atmosphere and no sleep difficulties. In addition, moderate exercise was well tolerated for one-hour periods at 3% carbon dioxide though this was no longer feasible at 4%. Not only was physiologic adaptation accomplished but no decrements were seen in the programmed psychological and psychomotor tests. Although we are not advocating a high carbon dioxide environment for spacecraft atmospheres, perhaps too much emphasis has been placed on the deleterious effects of this gas at even lower levels than encompassed in our study. Author

N68-20552# School of Aerospace Medicine, Brooks AFB, Tex.
BENDS IN SIMULATED EXTRAVEHICULAR ACTIVITY
Robert G. McIver, Thomas H. Allen, Sarah E. Beard, and R. W. Bancroft *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 129–138 refs (See N68-20545 10-04)

In order to avoid decompression sickness in subjects during simulated manned space flight experiments, four hours of denitrogenation time are recommended before decompression to 5 psia or less. If the MOL atmosphere is mixed gas and the subject has equilibrated with this atmosphere then the oxygen breathing time can be reduced to one hour before evacuation takes place. The development of neurological symptoms, circulatory symptoms, chokes, paesthesias, and pronounced joint pains calls for recompression to 14.5 psia and 100 percent oxygen breathing before a re-ascent to 5 psia can be undertaken. The author recommends to subject MOL pilots to safe decompression profiles as part of their training. G.G.

N68-20553# School of Aerospace Medicine, Brooks AFB, Tex.
WHAT HAS SPACE EXPERIENCE TAUGHT US ABOUT DISORIENTATION?
Paul A. Campbell *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 139–149 refs (See N68-20545 10-04)

The importance of the summed activities of the kinesthetic and proprioceptive senses emanating from muscles, viscera, skin, etc. is outlined and their functions of identification with the orbiting spacecraft through the media of seats, couches, restraints, etc. are discussed. Flight experience in itself is also a selection device and qualification criterion for participation in space flight as well as man's adaptation to various g forces. G.G.

N68-20554# School of Aerospace Medicine, Brooks AFB, Tex.
VESTIBULAR EXPERIMENTS IN GEMINI FLIGHTS 5 AND 7
Ashton Graybiel, Earl F. Miller, II, John Billingham, Richard Waite, Charles A. Berry et al *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 150–178 refs (See N68-20545 10-04)

One experiment dealt with nonvisual influences which might affect egocentric visual localization of the horizontal. The astronauts' task was to set a dim line of light, in an otherwise dark field, to an external horizontal reference; in weightlessness this reference was the recollection of an element of the spacecraft horizontal with respect to their seat; preflight and postflight it was their recollection of things horizontal with reference to the Earth while they were in a device upright with respect to gravity. Comparisons were made between the astronauts' inflight and preflight and postflight settings and between the settings made by the astronauts and by subjects in earlier experiments. The outstanding inflight findings were the small intratest and intertest variances manifested by all of the astronauts and the high degree of accuracy in the settings made by three of the four astronauts. From the theoretical point of view these findings imply that the E and A phenomena and the oculogravic illusion are the positive results of sensory inputs mainly of otolith and tactile and kinesthetic origin, responding, respectively, to gravitoinertial accelerations and weight. The second experiment consisted in the preflight and postflight measurement of ocular counterrolling which depends, for the greater part at least, on a reflex response having its genesis in the otolith apparatus. No significant differences between preflight and postflight responses were demonstrated. Author

N68-20555# School of Aerospace Medicine, Brooks AFB, Tex.
HUMAN TOLERANCE OF PROLONGED EXPOSURE TO A ROTATING ENVIRONMENT
D. B. Cramer *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 179–202 refs (See N68-20545 10-04)

Human adaptation to prolonged rotation shows an early ataxia period and the appearance of the nausea syndrome after some delay; during this period the rate of adaptation is greatest in more alert and active human subjects. A later perrotation period is characterized by a fatigue syndrom followed in the postrotation period by ataxia with rapid readaptation to the earth environment. Individual subjects show widely varying degrees of adaptation and can be classified into groups with high, average, or low levels of potential adaptation ability. Drugs might improve resistance to canal sickness by temporary suppression of the vestibular function. G.G.

N68-20556# School of Aerospace Medicine, Brooks AFB, Tex.
CALCIUM AND NITROGEN BALANCE STUDIES DURING GEMINI 7 FLIGHT
Leo Lutwak *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 203–232 refs (See N68-20545 10-04)

An attempt was made to perform complete metabolic balance studies on two astronauts during ten days pre-flight control phase, fourteen days of space flight, and four days of post-flight recovery phase, measuring intake and excretion of calcium, magnesium, phosphate, sulphate, nitrogen, sodium, potassium, and chloride. Considerable inter-individual variability was demonstrated, as would be expected, in all experimental parameters measured. Significant losses of phosphate were found inflight for both subjects with rapid recovery post-flight. Little change in nitrogen metabolism was noted in either subject. Patterns of excretion of sodium, potassium and chloride were different for each subject and were suggestive of changes in adrenal corticosteroid production. Sweat losses of calcium, magnesium, sulfate, nitrogen, phosphate were insignificant during all three phases. In order to arrive at generalizations concerning the effects of space flight on bone and muscle metabolism, more studies will have to be carried out in more subjects to account for individual variability, and under better control of dietary intake and collection of excreta. Author

N68-20557# School of Aerospace Medicine, Brooks AFB, Tex.
HYPODYNAMICS: CARDIOVASCULAR ASPECTS
Timothy N. Caris *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 233–239 refs (See N68-20545 10-04)

Changes in the cardiovascular regulatory mechanism during orbital flight, prolonged bed rest, or total body water immersion are used to explain the orthostatic postural intolerance that some pilots exhibit after assuming an erect posture. If man is maintained in a recumbent position, the hydrostatic column of blood due to gravity shortens considerably by a shift from the lower extremities to the rest of the body, primarily into the vascular beds within the

chest. Thus, increasing amounts of sodium and water are excreted until the shifted fluid is eliminated and the increased circulating blood volume results in increased filling of the heart chambers and inhibition of the normal antodiuretic hormone by the pituitary gland. Exposure of the lower half of the body to negative pressures for two or three days after prolonged bed rest results in plasma volume repletion and complete tolerance to orthostasis. G.G.

N68-20558# School of Aerospace Medicine, Brooks AFB, Tex.
ERYTHROKINETIC CHANGES IN MAN ASSOCIATED WITH BED REST
Bernard S. Morse *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 240–254 refs (See N68-20545 10-04)

A significant reduction in red cell mass was observed at the completion of 35 days of bed rest. A decreased rate of erythropoiesis was documented by serial reticulocyte counts. Upon resuming ambulation at the completion of bed rest, there was an accelerated rate of erythropoiesis and evidence suggestive of a mild hemolytic process. Author

N68-20559# School of Aerospace Medicine, Brooks AFB, Tex.
HYPODYNAMICS: METABOLIC ASPECTS
Malcolm C. Lancaster *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 255–263 refs (See N68-20545 10-04)

The metabolic changes associated with prolonged bed rest that appear to be significant at present are those that seem to be the result of the decrease in physical activity. The atrophy and weakness of muscles and the calcium loss appear to be from this effect. The potential deleterious effects of the calcium loss are weakening of trabecular bone structure and renal lithiasis. Author

N68-20561# School of Aerospace Medicine, Brooks AFB, Tex.
APPLICATION OF AEROSPACE MEDICAL DEVELOPMENTS IN CLINICAL MEDICINE
Thomas H. Crouch *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 282–298 (See N68-20545 10-04)

Applications of aerospace hardware and pressure chamber methods in clinical usage is discussed together with a step-by-step planning system for coordinated efforts mounted against specific diseases. Information collection, manipulation, retrieval, and communication aspect absorption into hospital information systems and research programs allows the physician to use his time more efficiently and to continue and update his education. Applied aerospace hardware constitute silicone parts, artificial heart valves, electronic pacemakers, radiotelemetry monitors for the critically ill, pressure respirators, hyperbaric pressure in surgical techniques, prostheses, etc. G.G

N68-20562# School of Aerospace Medicine, Brooks AFB, Tex.
CARDIAC RESPONSES TO ACCELERATION STRESS. 1: INSTRUMENTATION AND TECHNICS
H. Fred Stegall *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 299–311 refs (See N68-20545 10-04)

Measurements of pressure, volume, flow, and vascular resistance in various body sites by appropriate techniques are needed in order to define the cardiovascular system responses to acceleration stress. Techniques which give reasonable quantitative measurements constitute pressure measurements by implanted transducers, sonic dimension gages for cardiac and vascular volume measurements, and dye dispersions and Doppler effects for blood flow measurements. G.G.

N68-20563# School of Aerospace Medicine, Brooks AFB, Tex.
CARDIAC RESPONSES TO ACCELERATION STRESS. 2: RESULTS IN HUMAN VOLUNTEERS AND EXPERIMENTAL ANIMALS
Hubert L. Stone *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 312–324 refs (See N68-20545 10-04)

Gas sensitive electrodes were implanted into supine animals in order to study the regional distribution of cardiac output during acceleration stress. Animals inhaled small amounts of hydrogen gas during determination of the tissue flow and desaturation of hydrogen from the tissues was recorded and replotted for analysis. At all levels of back angle above supine position, the tissue blood flow changed when the animal's head was raised above the horizontal; tissue blood flow declined rapidly until at 30° head-up a 68 percent reduction occurred at 3.7 with the body organs moving toward the vertebral column. Acceleration seems to effect the baroreceptor activity to maintain the cerebral blood flow and to prevent unconsciousness. Cardiac output and heart rate responses differed in man and dogs at positive accleration because the heart of a dog moved posteriorly to a much greater extent than than of man. G.G.

N68-20564# School of Aerospace Medicine, Brooks AFB, Tex.
RESPONSE OF THE BODY TO MECHANICAL FORCES—AN OVERVIEW
Henning E. von Gierke *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 325–344 refs Conf. Presented on Prevent. of and Protect. Against Accidental Explosion, Ammunitions, Fuels and Hazardous Mixtures, New York, 10–13 Oct. 1966 Submitted for publication (See N68-20545 10-04)
(AMRL-TR-66-251)

Starting with present-day knowledge of the dynamic and strength properties of various types of tissue, the dynamic response of the complex body structure to the various types of force application is reviewed. The different methods for the collection of experimental data on man and animals are described and the combined information is used to give an integrated overview of the body's dynamic response to environmental pressure (acoustic loading, blast overpressure or decompression) as well as force changes (whole body vibration, whole body impact and small area impact). Examples of theoretical models describing the response of the whole body as well as models describing specific subsystems such as the respiratory system, the skull or the ear are presented. The discussion covers the status, value, and limitations of such theoretical models for explaining physiological and pathological findings, for predicting the body's response to force environments not yet experienced, for extrapolating biodynamic data among the mammalian species including man, and for aiding in formulating biomedical criteria for not only estimating various human hazards but for guiding those interested in safety and protection engineering. Author

N68-20565# School of Aerospace Medicine, Brooks AFB, Tex.
SPACE CABIN TOXICOLOGY
Anthony A. Thomas *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 345–368 refs (See N68-20545 10-04)

Simulated space cabin toxicology experiments on groups of animals exposed to atmospheres containing pulmonary irritants, fundamental cabin atmospheres, or off-gas products from cabin materials are reported. Results show that continuous exposure to contamination leads to a "summation of interest" type of toxic effect because daily recuperative periods from exposure do not exist. Both reduced barometric pressure and oxygen rich atmospheres influence the toxic damage effect. G.G.

N68-20566# School of Aerospace Medicine, Brooks AFB, Tex.
PROPELLANT TOXICOLOGY
Kenneth C. Back *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 369–383 refs (See N68-20545 10-04)

Propellant toxicology was evaluated by observing possible changes in subcellular elements as they relate to enzyme systems and energy kinetics in correlation with histopathological microscopy.

Toxicity tests with hydrazines showed that 25 mg/kg of pyridoxine protect man against convulsions in case of severe exposure to UDMH. Monomethylhydrazine toxicity caused specific changes in kidney and liver functions of monkeys and needs the combined administration of glucose as well as pyridoxine to prevent convulsions and deaths. Fluorine toxicity tests on rats concentrated in thyroid uptake of fluoride concentrations with return to normal after a few weeks. G.G.

N68-20567# School of Aerospace Medicine, Brooks AFB, Tex.
PERSONAL HYGIENE AND SANITATION IN AEROSPACE SYSTEMS
Alton E. Prince *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 384–395 refs (See N68-20545 10-04)

The nutritional requirements of young men, confined for various periods of time in simulated space environments, and the establishment of criteria for personnel hygiene and sanitation were evaluated. Microbiological sampling analyses found that corynebacteria keep staphylococci under some degree of control regardless of body cleansing procedures or environmental changes. Recommendations developed for space missions up to 30 days advocated the cleaning of body surfaces with moistened disposable paper wipes; an average of three per day was considered sufficient. Teeth should be cleaned once a day with a tooth brush and plain water and a rubber interdental stimulator should be used if desired. G.G.

N68-20571# Aerospace Medicine, Brooks AFB, Tex.
WORLD-WIDE AEROMEDICAL EVACUATION AND RECENT DEVELOPMENTS
Harold F. Funsch *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 440–463 refs (See N68-20545 10-04)

Long and extensive experience has demonstrated that any patient capable of being moved can be transported by air. Aerial movement has played a key role in improving survival rates of the wounded. Rapid, safe movement of casualties to field hospitals, and thence to larger medical centers, has made prompt specialized care possible. During his transportation, the patient is kept under continuous medical surveillance. He is carefully screened at the casualty staging centers of both the aerial ports of embarkation and debarkation. He receives medication and ancillary care in flight. Special equipment is utilized for cases requiring suction, oxygen, respiratory assistance, traction and the like. Second, early and safe evacuation of patients reduces the strain on the overseas medical facilities in the field, thereby increasing their potential for managing casualty surges. And finally, aeromedical evacuation permits the conservation and centralization of the large but by no means unlimited resources of military medicine, limiting the requirement for constructing additional expensive fixed medical facilities overseas. Author

N68-20574# School of Aerospace Medicine, Brooks AFB, Tex.
SOLVED AND UNSOLVED SPACE MEDICAL PROBLEMS INTERNATIONAL STATUS: 1966/1967
Hubertus Strughold *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 520–535 refs (See N68-20545 10-04)

Longer orbital space flight durations for manned lunar and planetary landing missions require spacecraft protection against puncture by meteors, preventive measures against corrosion effects on windows and communication equipment, as well as shielding against energetic particle rays. Communications from earth bases can advise orbiting astronauts on imminent dangers from solar flares and proton showers. Electromagnetic radiation effects on the physiological circadian cycle can be reduced by alternating sleep and activity phases within nearly the inherited time frame. Gravitational stimulation of the gravireceptors in near weightlessness environments can be provided by carrying some ballast. A Mars landing mission is feasible when proper precautions are taken in regard to atmospheric pressure, temperature, logistics problems, etc. G.G.

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N68-19593*# Texas Christian Univ., Fort Worth.
VERBAL ESTIMATION OF DISTANCE IN A SIMULATED SPACE ENVIRONMENT
Malcolm D. Arnoult, Bill R. Brown, Robert J. Vincent, and Sandra Tees [1967] 35 p refs
(Contract NAS2-1481)
(NASA-CR-73206) CFSTI: HC $3.00/MF $0.65 CSCL 05H

Preliminary work has indicated that when subjects (Ss) are given no information other than the real size of the target, verbal estimates of distance over the 200–5000 ft range tend to have a median error of about 55%, with errors on individual trials running as high as 1000%. Two experiments investigated possible ways of improving the accuracy of verbal judgments. Effects due to kind of stimulus sequence (random or sequential), distance range, and the presence of verbal anchors were examined. In the first experiment the limits of the distance range being used were shown and identified to the Ss before each set of 10 judgments of randomly chosen distances. The use of these anchors reduced the median error to about 15%. A second experiment investigated the effect of sequential presentation of distances. The effect of anchors was about the same, but there were also some adaptation effects stemming from the sequential order of stimulation. Author

N68-19653# Oak Ridge National Lab., Tenn.
HEALTH PHYSICS DIVISION Annual Progress Report, Period Ending Jul. 31, 1967
Oct. 1967 353 p refs
(Contract W-7405-ENG-26)
(ORNL-4168) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. RADIOACTIVE WASTE DISPOSAL, PART 1 Tsuneo Tamura, E. R. Eastwood, Joseph Shalhevet, A. S. Rogowski, F. S. Brinkley et al p 3–60 refs

2. RADIATION ECOLOGY, PART 2 S. I. Auerbach p 61–118 refs (See N68-19654 10-05)

3. RADIATION PHYSICS, PART 3 G. S. Hurst p 119–182 refs (See N68-19655 10-24)

4. RADIATION DOSIMETRY, PART 4 J. A. Auxier p 183–230 refs (See N68-19656 10-04)

5. INTERNAL DOSIMETRY, PART 4 W. S. Snyder p 231–288 refs (See N68-19657 10-04)

6. HEALTH PHYSICS TECHNOLOGY, PART 6 B. R. Fish p 289–344 refs (See N68-19658 10-05)

N68-19654# Oak Ridge National Lab., Tenn.
RADIATION ECOLOGY, PART 2
S. I. Auerbach *In its* Health Phys. Div. Oct. 1967 p 61–118 refs (See N68-19653 10-05)

The following topics are discussed: (1) *Responses of Animal Populations to Ionizing Radiation*—radiation effects on small mammals, bagworms, and insects, population genetics and survival, and

radioactive isotope movements in food chains; (2) *Responses of Plants to Ionizing Radiation*—radiosensitivity and genetic modifications in forest trees, and radionuclide uptake in plants; (3) *Radionuclide Cycling in Terrestrial Ecosystems*—radionuclide movements in forest landscapes, and microcosms; (4) *Radionuclide Cycling in Aquatic Ecosystems*—uptake and metabolism effects in fish, aquatic food chains, macroinvertebrates, and radiation effects on fish reproduction; (5) *Watershed Aquatic Habitat Interactions*—land–water interactions and transport of radionuclides in river water; (6) *Theoretical and Systems Ecology*—*systems identification, radiant energy budget of forest, vertical periphyton growth, and geochemical denudation; and (7) Forest Management*—linear programming for forest regulation. G.G.

N68-19658# Oak Ridge National Lab., Tenn.
HEALTH PHYSICS TECHNOLOGY, PART 6
B. R. Fish *In its* Health Phys. Div. Oct. 1967 p 289–344 refs (See N68-19653 10-05)

Work is reported on: (1) *Aerosol Physics*—particle adhesion to particles and plane surfaces, colorimetric studies on particle electricity, exploding wire aerosol generator, airborne vapor and particle interactions, and particle retention deposition on skin; and (2) *Applied Internal Dosimetry*—gamma ray spectrometry facility for detection and measurement of internal contamination, elimination of injected isotropic mercury, absorption of X-rays from transuranic elements, and radiostrontium for sample analysis. G.G.

N68-19696 Washington Univ., Seattle.
ADULT AGE DIFFERENCES IN THE PERCEPTION OF VISUAL ILLUSIONS
Frank Douglas Gajo (Ph.D. Thesis) 1966 110 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7036

The present experiment thus purported to study the relation between chronological age and susceptibility to these illusions in a study which emphasizes experimental controls, psychophysical procedures, and the criterion measures of the illusory effects. First, it was hypothesized that there is an age x procedure interaction to the effect that differences in susceptibility with age past maturity depend upon the type of procedure used. The second hypothesis tested stated in essence that when procedure is held constant, the magnitude of error in the Müller–Lyer illusion and in the Satellite circles illusion is not a function of chronological age in adult subjects. The third specific hypothesis tested refers to the interaction between age, procedure, and illusion and states that the difference between the Müller–Lyer illusion and the Satellite illusion, associated with chronological age, will be dependent upon the type of procedure used. Dissert. Abstr.

N68-19705*# Texas Christian Univ., Fort Worth.
DISTANCE DISCRIMINATION IN A SIMULATED SPACE ENVIRONMENT
Robert J. Vincent, Bill R. Brown, and Malcolm D. Arnoult 5 Jan. 1968 17 p refs
(Contract NAS2-1481)
(NASA-CR-73205) CFSTI: HC $3.00/MF $0.65 CSCL 05H

The Just Noticeable Difference (JND) for distance was investigated by a paired-comparisons method using successive comparisons. The research utilized an optically simulated large target located in a textureless environment at distances along the saggital plane out to 12,800 ft. The value of ΔD/D varied from less than 3% at 200 ft to about 7% at 12,800 ft. The results confirm the power function relationship between distance threshold and observation distance. Author

N68-19769# Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.
NEW CORRELATION BETWEEN A HUMAN SUBJECT AND A QUANTUM MECHANICAL RANDOM NUMBER GENERATOR
Helmut Schmidt Nov. 1967 54 p ref
(D1-82-0684)

Between some experimenters and a quantum mechanical random number generator, there appears to exist a type of coupling which contradicts currently accepted physical laws. This tentative conclusion was based on a series of experiments on an apparatus that consists of a device utilizing a quantum process to generate random numbers modulo 4. This random number generator is connected to four lamps and four corresponding pushbuttons in such a way that there is no correlation between the number of the button pressed and the number of the lamp lighted, as well as no correlation between successively generated random numbers. A preliminary study was made in which a large number of human operators was asked to press buttons manually; and it was found that certain individuals consistently scored higher than expected, that is, they pressed buttons to light lamps and make so-called hits. Three of these experimenters later obtained 16,456 hits out of 63,066 trials; and the probability of obtaining such a result by chance alone is less than 2×10^{-9}. M.W.R.

N68-19774# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
ORBITAL EXTRAVEHICULAR MOCKUP DESIGN
Paul Iribe Jan. 1968 20 p
(Contract NOw-62-0604-c)
(APL-TG-957; AD-665287)

Extravehicular activities (EVA) in space such as inspecting orbiting spacecraft, servicing orbiting equipment (e.g., an orbiting telescope), performing assembly tasks in space, and making space rescues will require an extravehicular work platform. The proposed one-man extravehicular work platform is an example of extreme man-machine integration. A study of the requirements for extravehicular protection and operation for such activities led to the immediate construction of a full-scale mockup of the required type of platform in order that it might serve as a focus for discussion, give a first look at the engineering feasibility of the platform, arbitrarily reduce the number and variety of contending designs, and be useful in future studies. The principal design features of this full-scale mockup are described. Of the contending designs, the one chosen for the mockup was a modularized backpack equipped with a propulsion capability, a backup for a portable life support system (PLSS), a communication subsystem for voice and telemetry, a TV monitoring subsystem, a rechargeable electrical power source, and pack-mounted illumination and mechanical manipulators. The basic design can be augmented by special modules to meet the requirements of particular missions. Author (TAB)

N68-19813 New School for Social Research, New York.
THE INFLUENCE OF ATTENTION AND AWARENESS ON VISUAL PERCEPTION
Dorothy C. Poster (Ph.D. Thesis) 1966 88 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-4795

The problem of the role of awareness in visual perception was to be investigated by presenting stimulus material in the peripheral field while the subject's attention was actively engaged in the central field. Under these conditions, with the stimulus input sufficient to ensure registration, the question raised was is it possible that the stimulus can affect the nervous system so that psychological after effects such as recall, recognition, etc., can be obtained? It was concluded that when attention is actively engaged and there is unawareness of a critical visual stimulus, even with maximum stimulus input, neither recall nor recognition can occur.

Some awareness seems to be a necessary condition for these processes to occur. However, the results provide evidence that a memory trace, in the absence of awareness of the stimulus, can influence the subsequent organization of at least one kind of ambiguous material. Dissert. Abstr.

N68-19828# Naval Research Lab., Washington, D. C.
THE SEALAB 2 TRACE-CONTAMINANT PROFILE
Raymond A. Saunders and Richard H. Gammon 4 Dec. 1967 17 p refs
(NRL-6636; AD-664946)

Adsorption of contaminants on activated charcoal was one of the methods used to sample the atmosphere of Sealab II. The contaminant material was later recovered by slowly heating the charcoal in an evacuated system and retaining the desorbate in liquid-nitrogen-cooled traps. The desorbate mixture was resolved with a vapor-phase chromatograph. The eluted components were passed directly into a rapid-scanning mass spectrometer for positive identification. Components were also collected from the effluent of the chromatograph and identified by means of their infrared spectra. Over 30 different compounds were identified in the charcoal desorbate. Added to those already known, the total number of atmospheric contaminants which have been identified in Sealab II now amounts to 40. These include refrigerants, saturated and unsaturated aliphatic hydrocarbons, cyclic aliphatic hydrocarbons, chlorinated hydrocarbons, and aromatic hydrocarbons. The characteristic feature of the Sealab II contaminant profile, like that of Sealab I, was a predominance of hydrocarbon contaminants. Some of the more prominent contaminants in the Sealab II atmosphere were cyclic aliphatic hydrocarbons which are not generally encountered as dominant trace contaminants in closed environmental atmospheres. Author (TAB)

N68-19841# HRB-Singer, Inc., State College, Pa.
AUDITORY EVALUATION
W. R. Stover Johnsville, Pa. Naval Air Develop. Center 30 Nov. 1967 74 p
(Contract N156-67-C-0929)
(NADC-AC-6709; AD-665002)

The investigation focused attention upon the development of multi-dimensional hearing tests which could yield new insights to normal and abnormal states of hearing and to auditory communications under a variety of conditions. The broad results indicate that the new approach can provide significant information about auditory mechanisms. Within the limits of the test conditions, background noise affected phoneme recognition by subjects with normal hearing, conductive hearing loss, and sensori-neural hearing loss in qualitatively similar ways, with trends toward quantitative differences. The detailed findings provide a basis for planning the construction of more precise tests along theoretical and methodological lines. Author (TAB)

N68-19883# School of Aerospace Medicine, Brooks AFB, Tex.
NUMERICAL MARKING ABRASIVE UNIT, JULY–OCTOBER 1966
Heinz A. Jaeger and William G. Glenn Sep. 1967 13 p refs
(SAM-TR-67-83; AD-664896)

An industrial abrasive unit was modified to enable precise, repetitive abrading of small glass columns. The abraded areas completely circle the tubes at preselected intervals. When such markings are scanned by a light beam - photocell combination, they can be graphically recorded as a series of spikes. The presence or absence of spikes at certain intervals can be transposed into Arabic numbers by using a modification of the conventional binary coded decimal. Using numbers 00 to 99 at the top, bottom, or combination of top and bottom of the tubes permits 9,999 different designations. TAB

N68-19915# Naval Research Lab., Washington, D. C.
A COMPARISON OF THREE TYPES OF MANUAL CONTROLS ON A THIRD-ORDER TRACKING TASK
P. N. Ziegler and R. Chernikoff 20 Dec. 1967 16 p refs
(NRL-6646; AD-665001)

Three types of control levers--the spring-centered-displacement control, the on-off control, and the pressure control--were compared on a third-order compensatory tracking task. Based on an analysis of the control transfer functions, the predicted ranking of the three controls are: (1) pressure, (2) displacement, and (3) on-off. The results of a study in which five subjects tracked six trials with each control for 18 sessions were as follows: The data at the beginning of training indicated rankings of (1) pressure, (2) on-off, and (3) displacement. However, the data taken during the latter sessions ranked the controls as predicted, although the difference between displacement and on-off was not statistically significant. Differences in results between early and late training and comparisons of these results with other studies are discussed. Author (TAB)

N68-19940# Human Engineering Labs., Aberdeen Proving Ground, Md.
EFFECTS OF MUSIC ON WORK PERFORMANCE
William Wokoun Jan. 1968 46 p refs
(TM-1-68; AD-664749)

Sixty-three subjects worked at a vigilance task for an hour while listening to one of three musical programs. While all three programs included the same 23 selections, the Ascending Program grew steadily more lively, and the Descending Program grew steadily less lively, while the Increasingly Variable Program progressively increased the contrast between adjacent selections. Results showed that changing the sequence of the 23 selections profoundly affected reaction times and variabilities, as well as individual consistency. Subjects performed the vigilance task better with the Ascending Program than with the other two programs. Author (TAB)

N68-19953# Naval School of Aviation Medicine, Pensacola, Fla.
THE NAVAL AVIATOR'S SPEED DISCRIMINATION TEST: INSTRUMENTATION AND TECHNIQUE
James W. Greene 6 Dec. 1967 25 p refs
(NAMI-1027; AD-665038)

The Naval Aviators Speech Discrimination Test (NASDT), formulated in 1964, is used by the Bureau of Medicine and Surgery to evaluate aviators who fail to meet the hearing standards for aviation. The nature of the test, which involves a listening task for high-level speech signals with a simulated aircraft noise background, requires a tape recorder and earphone configuration. Two similar systems of test presentation have been developed and are in current use at 18 Navy and Marine Corps installations. The devices produce the properly controlled test signals required for the NASDT and are easily operated by trained corpsmen. Additional information is presented to enable the user of either system to administer the test properly. Author (TAB)

N68-20006# Flying Personnel Research Committee, London (England).
FURTHER STUDIES UPON THE HUMAN ASPECTS OF FIRE IN ARTIFICIAL GAS ENVIRONMENTS
D. M. Denison and W. J. Tonkins Sep. 1967 31 p refs
(FPRC/1270)

This paper extends a series reporting work upon the problems of fire in various artificial gas environments suitable to man. The object of the present study has been limited to obtaining a more precise idea of what would happen to a clothed man if he came in contact with an ignition source in these surroundings. Author

N68-20023 Illinois Univ., Urbana.
DYNAMIC ANALYSIS OF SPEECH SIGNALS
Ian Bryce Thomas (Ph.D. Thesis) 1966 167 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-6755

A new experiment is described in which the contributions of first and second formant to the intelligibility of clipped speech are measured. The figures obtained for the second formant test confirm that the second formant is a major contributor to speech intelligibility. A Second Formant Tracker was designed and constructed to examine the behavior of the second formant in connected speech. A transient approach to the analysis of speech signals was proposed which contrasts sharply with the Fourier methods now in general use. Examination of the outputs of the second formant tracking device shows that there is a logarithmic similarity between these outputs for the same words enunciated by many speakers. Finally, a real-time Speech Analysis-Synthesis Machine was constructed and tested which utilizes only second formant information in the generation of synthetic speech. The results of articulation tests performed with this machine are presented and discussed. Dissert. Abstr.

N68-20050# Applied Science Associates, Inc., Valencia, Pa.
EFFECT OF AMBIGUOUS TEST RESULTS ON TROUBLESHOOTING PERFORMANCE Final Report, Apr. 1966–Apr. 1967
William J. Pieper and John D. Folley, Jr. Wright-Patterson AFB, Ohio AMRL Nov. 1967 39 p refs
(Contract AF 33(615)-3966)
(AMRL-TR-67-160; AD-664891)

Forty-eight high school boys, used as subjects, were divided into eight groups of six each. Four of the groups were composed of medium electronic aptitude subjects having scores in the 40 to 65 percentile range on the Airman Qualifying Exam - 62. The other groups contained subjects with high, 75 to 99 percentile, electronic aptitude. Each subject received 11 hours of training and practice in isolating malfunctioning components in data-flow diagrams using the half-split strategy. During testing each subject group worked 24 paper and pencil between-stage troubleshooting problems, one set of 6 at each of four levels of ambiguity (0%, 10%, 20%, and 40%). The performance measures used were: (1) isolation time, (2) number of isolation tests, and (3) identification errors. Subject aptitude had the greatest effect on speed (isolation time) and accuracy of identifying the guilty component (identification errors). On the other hand, aptitude had no effect on the application of the troubleshooting strategy since both medium and high aptitude subjects used the same number of tests in solving the problems. Ambiguity of test results affected speed, accuracy, and application of the strategy. The greater the percentage of ambiguous test results, the more time required, the less accuracy attained, and the greater the number of checks used in solving the problems. As expected, the four problem sets had significant effects on speed, accuracy, and the number of tests used to solve the problems. However, there were no significant interactions between this variable and aptitude, ambiguity, or the aptitude by ambiguity interaction. Author (TAB)

N68-20081# State Univ. of New York at Buffalo. Dept. of Psychology.
EFFECTS OF PRIOR AGREEMENT FROM OTHERS ON TASK CONFIDENCE AND CONFORMITY
James W. Julian, C. Robert Regula, and Edwin P. Hollander Nov. 1967 26 p refs
(Contract Nonr-4679(00))
(TR-9; AD-664819)

An experiment was conducted to explore further the relationship between prior agreement from others and subsequent conformity to their erroneous judgments. 240 Ss were arrayed in a 2 x 6 x 2 factorial design with sex, levels of prior agreement, and two questionnaire conditions defining each of the factors respectively. Two related hypotheses were tested: (1) that task confidence is a direct function of the level of prior agreement experienced, and (2) that conformity is curvilinearly related to the level of task confidence and prior agreement. Task confidence was thus hypothesized to mediate the relationship between agreement and conformity. During phase one of the procedure, Ss responded in the first position of a modified Crutchfield apparatus, where they saw either 100%, 75%, 50%, 25%, or 0% of their peers agree with them on each of 20 judgments of an unambiguous stimulus. In a control condition, no feedback was provided. In phase two, Ss shifted to the usual last response position and their conformity was assessed. Results confirmed the hypotheses. In addition, sex differences in reaction to prior agreement were explored. Author (TAB)

N68-20077# Naval Personnel Research Activity, San Diego, Calif. Navy Training Research Lab.
PREDICTION TABLES FOR AVIONICS FUNDAMENTALS COURSE, CLASS A
Robert O. Baldwin and Kirk A. Johnson Feb. 1968 32 p refs
(SRM-68-15; AD-665288)

In September 1966 a 16 week Avionics Fundamentals course was implemented in place of the 19 week course. Tables to predict the expected grades of students in the new course were constructed. Graphs for predicting the probability of receiving a setback and the probability of graduating after receiving a setback were also constructed. Author (TAB)

N68-20125*# Naval School of Aviation Medicine, Fla.
CROSS-VALIDATION OF A BRIEF VESTIBULAR DISORIENTATION TEST ADMINISTERED BY A VARIETY OF PERSONNEL
Rosalie V. Ambler and Fred E. Grady, Jr. 24 May 1967 7 p refs
(NASA Order R-93)
(NASA-CR-93836; NAMI-1009; USAARU-JR-67-4) CFSTI: HC $3.00/MF $0.65 CSCL 05H

A Brief Vestibular Disorientation Test (BVDT) was developed that involves observer assessment of subjects' reactions produced by head movements in a rotating chair. Promising validity coefficients have been reported for a criterion of pass versus separation from pilot training. This study cross-validated the BVDT under observer conditions approximating field use. The test was administered to 239 aviation trainees during pre-flight training. The number of observers per subject varied from two to four. Thirteen observers with a variety of backgrounds participated. BVDT scores were correlated with four criteria: (1) students separated from training for all causes versus completions; (2) tension separations versus all others; (3) airsick separations versus all others; and (4) tension and/or airsick separations versus all others. Significant relationships existed between high sensitivity scores on the BVDT and membership in all four groups. The addition of the BVDT significantly augmented the magnitude of the multiple correlations of the existing aviation selection variables with the criteria. Author

N68-20263# Army Medical Research Lab., Fort Knox, Ky. Experimental Psychology Div.
SENSE MODE AND COUPLING IN A VIGILANCE TASK Progress Report
Jimmy L. Hatfield and Michel Loeb 18 Oct. 1967 90 p refs
(USAMRL-753; AD-664760)

The investigation examined the performance of thirty-six subjects on three 90-minute vigilance tasks. Response measures for signals were available in three basic forms: hits, false alarms, and response latency. In addition, parameters of signal detection, decreased sensitivity (d) and observers criteria (beta) were derived

from the data. There was a significant decrease in hits and false alarms with increasing time on task, regardless of sense mode and coupling conditions, or the number of signal intensities. In general, when detection rate decreased, reaction time increased. The consistent sequential relationship between the stimulus conditions suggests that there are uniform trends among conventional response measures. There was a significant decline in sensitivity (d) with increasing time on task for the closely coupled tasks, regardless of sense mode involved, but d remained fairly stable for the loosely coupled visual task. In this experiment, beta values increased significantly for all vigilance tasks. There is a tendency, therefore, for the observer to adopt a more conservative mode of responding with increasing time on task. Orthogonal comparisons of that portion of the variance due to stimulus conditions clearly establish coupling effects as a critical independent variable. Numerous significant correlation coefficients of vigilance performance are reported and current methodological problems associated with this area of research are discussed in detail. Author (TAB)

N68-20265*# Serendipity Associates, McLean, Va.
THE PROBLEM OF OFF DUTY TIME IN LONG DURATION SPACE MISSIONS. VOLUME 1: SUMMARY AND RESEARCH RECOMMENDATIONS
John W. Eberhard Oct. 1967 33 p refs
(Contract NASw-1615)
(NASA-CR-93834; TR-55-67-13(U), V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 05E

As the psychological and social problems related to long duration space flights warrant careful consideration of off-duty time, an analysis was conducted to determine the amount of available time and effective ways of using it. Representative long duration missions were reviewed to obtain estimates of the scheduled and unscheduled off-duty time, and the time allocated to work, sleep, and contingencies. The summary tabulation shows a total off-duty time of 9.8 to 12.6 hours per 24-hour day. Data on the off-duty time patterns of both general and special populations were also reviewed, and the key facts about time utilization are summarized. Discretionary activity possibilities were determined. The results indicate that the off-duty time and activity patterns of isolated groups differ from those of the general population, and that the activity patterns of individuals in confinement change over time. Research requirements are considered in the context of design criteria for including man in long duration space missions. Potential discretionary activities are listed. M.G.J.

N68-20339*# Environmental Research Associates, Randallstown, Md.
A STUDY OF THE PERFORMANCE OF AN ASTRONAUT DURING INGRESS AND EGRESS MANEUVERS THROUGH AIRLOCKS AND PASSAGEWAYS
Harry L. Loats, Jr. and William J. Bruchey, Jr. Washington NASA Apr. 1968 163 p refs
(Contract NAS1-4059)
(NASA-CR-971) CFSTI: HC $3.00/MF $0.65 CSCL 05H

The performance characteristics of a pressure-suited astronaut during ingress–egress through various geometry airlocks were studied by water immersion techniques. The buoyancy force induced by water displacement of a totally immersed subject was used to counteract all or part of his adjusted total weight to provide the desired simulated gravity level. The subject performed real-time maneuvers as determined from functional analysis of representative extravehicular and intravehicular tasks. The purpose of this phase of the contract was to generate additional data on refined experiments initiated under previous contractual phases and to expand the experiment scope to include rescue, replenishment and general maneuvers exterior to the airlock. The effect of the variation of airlock dimension and shape on the capabilities to perform manual ingress–egress was evaluated by comparative time-task analysis. Author

N68-20354*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF PRESSURE SUITS AND BACKPACK LOADS ON MAN'S SELF-LOCOMOTION IN EARTH AND SIMULATED LUNAR GRAVITY
Amos A. Spady, Jr. and Randall L. Harris Washington Apr. 1968 46 p refs
(NASA-TN-D-4464) CFSTI: HC $3.00/MF $0.65 CSCL 05E

Studies were conducted to evaluate the effect of a state-of-the-art full pressure suit on man's self-locomotion capabilities in earth and simulated lunar gravity. Separate tests, with subjects wearing lightweight coveralls, were also conducted in simulated lunar gravity to determine the effect on locomotion of carrying backpack loads of up to 500 earth pounds. The simulated lunar tests were conducted on a modified version of the reduced-gravity walking simulator. Tests in earth gravity were performed on a portion of asphaltic concrete road of length equal to that provided by the modified lunar-gravity simulator. The gait characteristics of the subjects were determined by having the subjects walk and run at various speeds. The results obtained with the pressure suit indicated that pressurizing the suit to 3.7 psig did not appreciably affect the subject's self-locomotive gait characteristics in lunar gravity. The results of the load-carrying tests indicated that a subject, dressed in lightweight coveralls, could carry a backpack loaded with 500 earth pounds while walking, loping, and sprinting in lunar gravity. Author

N68-20357*# National Aeronautics and Space Administration, Washington, D. C.
AN INTRODUCTION TO THE ASSURANCE OF HUMAN PERFORMANCE IN SPACE SYSTEMS
1968 42 p refs Prepared by Martin Co.
(NASA-SP-6506) CFSTI: HC $3.00/MF $0.65 CSCL 05H

To assess the role that man plays as a potential source of error in space technology, studies were conducted to determine what human performance assurance effort is appropriate for various projects and to show how this effort relates to various phases in the development cycle. A method for classifying programs and systems according to mission complexity and significance is developed, and human engineering and serviceability functions appropriate for specific development phases of the programs are categorized and described. Man–machine capabilities are summarized as an aid in determining the relative superiority of each. An example is presented in which the techniques are applied to a hypothetical micrometeoroid deep space satellite, a concept based on studies of an unmanned satellite program of medium-to-small cost and complexity. The reliability program provision for space system contractors, concerning prevention of human error, is included. M.G.J.

N68-20369*# Texas Univ., Austin. Defense Research Lab.
[CONDUCT STUDIES OF AUDITORY INFORMATION PROCESSING EMPHASIZING THE APPLICATION OF SIGNAL DETECTABILITY THEORY TO THE AUDITORY SENSORY RESPONSES] Semiannual Report, 1 Jun.–30 Nov. 1967; Quarterly Status Report, 1 Sep.–30 Nov. 1967
Lloyd A. Jeffress 3 Jan. 1968 44 p
(NASA Order R-129; Contracts Nonr-3579(04); NObsr-93124)
(NASA-CR-93854; QSR-14) CFSTI: HC $3.00/MF $0.65 CSCL 06B

Visual and auditory signal recognition research efforts are summarized. Effects of chromatic adaptation on color naming were studied, saturation estimates were made for chromatic adaptation, and effects of adaptation on visual detection were studied. The Bezold–Brücke hue shift was considered, and unique green loci for two classes of observers at two luminance levels were determined. Binaural research efforts deal with (1) time and intensity differences and lateralization, (2) masking-level differences for tone and

narrowband noise, (3) binaural detection as a function of the bandwidth of the masking noise, and (4) binaural electrical models and detection. Among the monaural phenomena studied are (1) the effect of vigilance in an auditory detection experiment, (2) width and shape of the critical band involved in masking, (3) gated noise and signal, and (4) the role of signal detection. Mathematical and electrical models were investigated; and the electrical model was studied as a predictor of observers' responses. Noncentral chi distribution and psychometric data are presented. M.W.R.

N68-20453*# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.

MEASUREMENT AND DISPLAY OF CONTROL INFORMATION. REMOTE MANIPULATION AND MANUAL CONTROL Progress Report, 1 Apr.–30 Sep. 1967

Thomas B. Sheridan and William R. Ferrell 30 Sep. 1967 28 p (Grant NsG-107-61)

(NASA-CR-93853; DSR-70283-6) CFSTI: HC $3.00/MF $0.65 CSCL 05H

An experimental program is described in which the microstructure of human controlled remote manipulation is investigated. On the basis of this study, all motion commands were classified as belonging to five routines: search, grasp, carry, put, and error adjustment. It is shown that the number of commands increases with increasing ambiguity in feedback, that this ambiguity depends on the number and size of touch sensors, and on the shape and size of the object being grasped, and that the size of the commanded motions decreases with increasing risk related to the human estimation of the probability of making an error. Based on these results, a computer program was written to provide a variable time delay for two analog voltage signals to be used with a two dimensional, continuous control task to determine the effect of time delay on control of a plant with dynamic lag. Data are compiled on the optimality of human controllers as time optimal, bang–bang state regulators for second order systems. The switching performance of each of three subjects for each of four second order systems using each of four types of displays is described. E.J.S.

N68-20455# Ohio State Univ., Columbus. Human Performance Center.

SOME PRINCIPLES FOR THE DESIGN OF DECISION SYSTEMS: A REVIEW OF SIX YEARS OF RESEARCH ON A COMMAND-CONTROL SYSTEM SIMULATION Final Report, 1 Apr. 1960–31 Aug. 1966

William C. Howell Wright-Patterson AFB, Ohio AMRL Sep. 1967 42 p refs

(Contracts AF 33(615)-2248; AF 33(616)-7122; AF 33(657)-10763)

(AMRL-TR-67-136; AD-665469)

A set of general principles for guidance in decision system development is presented based upon research findings obtained in a simulated (but highly generalized) command-control system. The chief objective of the research was evaluation of an automated procedure for assisting man in making diagnostic decisions. Briefly, this procedure involved aggregation by the machine of human evaluations of a number of separate items of reconnaissance data. Comparisons were made between performance of the system in assessing environmental states (e.g., enemy strategies) when the automated procedure was and was not in effect under a variety of task circumstances (e.g., load, level of information fidelity, feedback, etc.). The 13 principles thus formulated generally support the use of an automated aggregation procedure in diagnosis. Furthermore, they show that machine aggregation is most beneficial in circumstances which produce large amounts of low-quality data or those in which the human is placed under some sort of stress. Several of the principles suggest possible limitations on the use of machines in decision making. Author (TAB)

N68-20515# Lockheed Missiles and Space Co., Sunnyvale, Calif.

WEIGHTLESS SIMULATION USING WATER IMMERSION TECHNIQUES: AN ANNOTATED BIBLIOGRAPHY

J. H. Duddy, comp., O. T. Kallos, comp., V. D. Caswell, comp., and A. T. Vogt, comp. Dec. 1967 322 p refs Revised

(LMSC-5-24-65-3/SB-65-2, Rev. 2; AD-665278)

The compilation contains 215 selected references pertaining to behavioral and biomedical research involving human subjects. The references are organized under three topics: (1) physiological studies, including acceleration stress tolerance and physiological responses to simulated weightlessness; (2) human engineering studies of man's performance capabilities under neutral buoyancy conditions simulating weightlessness; and (3) techniques and personal equipment requirements for water immersion studies. The references are arranged alphabetically by author, or by title if appropriate, under each of the three topics. An author index is included as an aid in locating the contributions of specific investigators. The references cited were drawn from the literature published or privately distributed during the period from January 1951 through December 1967. Author (TAB)

N68-20548# School of Aerospace Medicine, Brooks AFB, Tex.

ADVANCED ASPECTS OF PRESSURE SUIT DEVELOPMENTS

Jefferson C. Davis *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 62–76 refs (See N68-20545 10-04)

New concepts in full pressure suit joint designs use bellows, mechanical joints or stove pipe joints. Mechanical pressure suits with passive pressurization inflate automatically at altitudes providing mechanical pressure. They contain an outer inelastic layer and an inner elastic layer sewn together so that they provide multiple pockets between them. Into these pocket are inserted expandable tubes containing a specific volume of room air. The helmet may be either a soft inflatable configuration or a hardhat for buffeting protection. Mobility in this suit at altitudes below 20,000 feet is comparable to conventional flying coveralls. G.G.

N68-20560# School of Aerospace Medicine, Brooks AFB, Tex.

VISION IN THE VOID

Hans-Georg Clamann *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 264–281 refs (See N68-20545 10-04)

Optical illusions are used to demonstrate that astronaut vision during space flights is not capable of objective recordings nor free from psychological errors. Without the indication of measurable distances by optical measurements or radar, the subjective distance estimate leads to misjudgements. Greater occurrences of visual illusions in color vision are partly attributed to the effect of simultaneous contrasts. There is strong evidence that the centers upward from the retina in the visual pathway toward the cortex act as parts of a computer mechanism and produce a mental visual image from the physical image. Thus, an astronaut outside of his spaceship might see the sky wrapped around the Earth and the Moon, forming an ellipsoid-like cavity. This ellipsoid may take various shapes depending on what celestial body is closest to it. G.G.

N68-20572# School of Aerospace Medicine, Brooks AFB, Tex.

INFORMATION PROCESSING ASPECTS OF BIONICS

Hans L. Ostreicher *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 464–480 refs (See N68-20545 10-04)

Information processing systems in bionics constitute interactions of living organisms with their environment primarily by motions of their bodies. The information enters the system through signal reception, is converted into the receptor organs routine operations and passed on to a central information processing stage. The output mechanism converts the internal code then into appropriate action and enables the system to interact with its

environment. The powerful method of pattern recognition has evolved in all higher animals and enables them to organize the stream of input data. An estimate of the information contained in output mechanisms shows a strong increase due to genetic and learnad programs stored in the bionic system. G.G.

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N68-19496# Virginia Inst. for Scientific Research, Richmond.
GROWTH AND PROPERTIES OF HYDROXYAPATITE SINGLE CRYSTALS Annual Comprehensive Report, 23 Jun. 1964–22 Jun. 1967
James F. Kirn and Henry Leidheiser, Jr. 22 Jun. 1967 70 p refs
(Contract PH-43-64-558)
(PB-176294) CFSTI: HC $3.00/MF $0.65

Four methods were attempted for the growth of large single crystals of hydroxyapatite: hydrothermal synthesis, growth in gels under hydrothermal conditions, growth in aqueous solution at 100C, and growth under conditions where the pH is controlled by the hydrolysis of urea. The best results were obtained in hydrothermal synthesis and crystals up to 3 mm. in length were obtained using CaHPO4 crystals as the nutrient and experimental conditions of 350C, and 8,000 lbs./sq. in. Epitaxial growth on seed crystals was obtained when SnO in low concentrations was used as an additive. Surface active agents, such as oleic acid, had an effect on the crystal growth in that growth parallel to the 'c' axis was restricted and growth on the prism faces was facilitated. Studies were made of the hardness and etching behavior of synthetic hydroxyapatite crystals. The synthetic crystals exhibited Vickers hardness values of 277–290 and 242 on the 'm' and 'c' faces, respectively. The corresponding values for natural crystals were 598 and 517. Etching studies of the synthetic crystals showed promise for illuminating structural imperfections. Author

N68-19527# Kernforschungszentrum, Karlsruhe (West Germany).
ON OXIDE, NITRIDE AND CARBIDE COMPOUNDS OF U–Ce–Zr [DES OXYDES, NITRURES ET CARBURES TERNAIRES DE U–Ce–Zr]
H. Holleck and W. Wagner Ges. fuer Kernforsc. m.b.H. Sep. 1967 25 p refs In FRENCH Presented at Conf. on Thermodyn. of Nucl. Mater. with Emphasis on Soln. System, Vienna, 4–8 Sep. 1967 Supported in part by EURATOM
(KFK-643; SM-98/13; EUR-3696.F) CFSTI: HC $3.00/MF $0.65

In considering combustible fission products, radiographic studies were carried out on the quasi-ternary systems UO_2–ZrO_2–CeO_{2-x}; UN–ZrN–CeN, and UC–ZrC–CeC. The solubility limits of $(Ce_y, Zr_{1-y})O_{2-x}$ in UO_2 are discussed for the temperature range of 1600° to 1800°C. Following the incorporation of trivalent cerium ions and oxygen vacancies, the solubility of cerium in the mixed phase $(U, Ce, Zr)O_{2-x}$ is reduced while that of Zr is augmented. At 1700° to 1800°C, a mixed monophase and cubic crystal is observed up to 80 mol% ZrO_2. In the quasi-binary systems UN–CeN and UN–ZrN, an extensive state of mixed crystals exists. In the UN–ZrN system, it is possible to obtain the homogeneous transition between 80 mol% UN and the pure UN for the conditions examined. At 2000°C, there is little chance of miscibility in the UN–CeN system which is close in composition to 60 mol% UN. Solubility in the ZrN–CeN system is weak. Transl. by M.G.J.

N68-19540# Argonne National Lab., Ill.
MACRODETERMINATION OF OXYGEN IN URANIUM DIOXIDE COMPOSITES BY INERT-GAS FUSION
Harvey T. Goodspeed and Dewitt Pettie Sep. 1967 9 p refs
(Contract W-31-109-ENG-38)
(ANL-7264) CFSTI: HC $3.00/MF $0.65

An inert-gas fusion method for the macrodetermination of oxygen in uranium dioxide composites is described. Sample sizes ranged around 300 mg. About 100 mg of CO_2 produced by the procedure was collected in absorption-weighing tubes and measured on a standard analytical balance. As an initial check on the method, it was applied with success to oxygen determinations for various standard materials other than UO_2 composites. When applied to uranium dioxide composites, the method gave results that again appear to be completely satisfactory when temperature is taken to be the critical factor and therefore controlled. Average recoveries of 99.9 and 100.1% of the theoretical oxygen content were obtained in the analysis of U_3O_8 and UO_2 standards, with standard deviations from the means of about 0.3%. The same degree of precision was obtained in the oxygen analysis of known samples of W–UO_2 composites. Results obtained in the oxygen analyses of composites of UO_2 and other metal oxides are presented in tabular form. Author (NSA)

N68-19544# Bureau of Mines, Reno, Nev.
A HIGH TEMPERATURE, TWO PHASE EXTRACTION TECHNIQUE FOR TUNGSTEN MINERALS
John M. Gomes, Kenji Uchida, and Don H. Baker, Jr. Apr. 1968 17 p refs
(BM-RI-7106)

A two-phase molten halide–silicate technique for extracting tungstic oxide (WO_3) from scheelite ($CaWO_4$) and wolframite [(Fe, Mn)WO_4] was investigated. The halide phase extracted over 99 percent of the WO_3 whereas the lower silicate phase retained about 90 percent of the calcium, iron, or manganese oxides. The most efficient extraction and separation of tungsten from scheelite was accomplished at 1,080°C in a molten system containing, in mole-percent, 9 calcium tungstate ($CaWO_4$), 42 sodium chloride (NaCl), 28 sodium fluoride (NaF), 17 sodium metasilicate (Na_2SiO_3), and 4 alumina (Al_2O_3). Wolframite was also treated at 1,080°C; the molten system contained, in mole-percent, 11 (Fe, Mn)WO_4, 74 NaCl, and 15 Na_2SiO_3. Author

N68-19550# Bureau of Mines, Amarillo, Tex. Helium Research Center.
MODIFIED REDLICH–KWONG EQUATIONS FOR HYDROGEN AND FOR NEON
Philip C. Tully and Jonnie M. Estes Apr. 1968 31 p refs
(BM-RI-7099)

These modifications to the Redlich–Kwong equations for pure hydrogen and neon were developed after an unsuccessful attempt to generalize a modification technique previously developed for helium. New coefficients of the B terms were developed by minimizing the residuals. No changes were made in the coefficients of the A terms. For normal hydrogen, B was changed to $0.08063T_c/P_cT$ for temperatures from 98° to 423°K and pressures up to 1,050 atm. The average deviation in Z was 0.34 percent with maximum deviations less than 1 percent for all but a few low-temperature points. For neon, B was changed to $0.1025T_c/P_cT$ for temperatures from 120° to 973°K and pressures up to 1,500 atm. The average deviation in Z was 0.34 percent with maximum deviations less than 1 percent for all but a few high-pressure and low-temperature points. Efforts to attain a lower temperature range to comparable accuracy with this type of modification were unsuccessful. In the range of applicability, these equations should be used with caution when calculating derived thermodynamic functions, such as the isobaric specific heat. Author

N68-19563# Technische Hochschule Munchen (West Germany).
CHROMATOGRAPHIC COLUMNAL ISOLATION OF ^{242}Cm IN 100 Ci RANGE OUT OF NEUTRON IRRADIATED ^{241}Am [DIE SAEULENCHROMATOGRAPHISCHE ISOLIERUNG VON ^{242}Cm IM 100 CI-BEREICH AUS NEUTRONENBESTRAHLTEM ^{241}Am]
Guenter Hoehlein (Ph.D. Thesis) [1967] 108 p refs In GERMAN

Method and facility for the mechanical and chemical separation from a 200 mg americium 241 sample irradiated in a high-flux reactor are described. The facility is remotely controlled and continuously monitored by gamma spectroscopy. The curium is separated from the americium, plutonium, and the fission products by means of cation exchangers. The trivalent actinides and lanthanides are absorbed on an exchange column, and ruthenium 103, zirconium 95 or niobium 95, and tetravalent plutonium 238 and 242 are eluted as sulfato or oxalato complexes. This is followed by further elution processes. The curium 242 is separated from the americium 241 in the presence of methanol, and 91.6% of the curium is separated with a purity of 98.5%. Transl. by K.W.

N68-19564# Bureau of Mines, Washington, D. C.
THE KINETICS OF OXIDATION OF MICRODISPERSED CARBON
Ya. P. Gokhshtein 1967 7 p refs Transl. into ENGLISH from Akad. Nauk SSSR. (Dokl.) v. 173, no. 1, 1967 p 143–147
(BM-TRANS-3323; PB-176508T) CFSTI: HC $3.00/MF $0.65

In relation to the search for a method of determining free carbon in boron carbides, an investigation was made of the behavior of dispersed carbon in oxidizing media. The subjects of the investigation were lampblack and type B graphite, preliminarily broken up by ultrasonics. The samples were oxidized in an atmosphere of argon plus CO_2 and in solutions of H_2SO_4 containing CrO_3 and $K_2Cr_2O_7$. On the basis of a comparison of theory with experiment, analysis was made of the kinetics of oxidation of a sample consisting of a large number of microparticles with predetermined distribution function of diameters. Author

N68-19576# Bureau of Mines, Albany, Oreg. Metallurgy Research Center.
CHROMIUM BY THERMAL DECOMPOSITION OF BISBENZENE CHROMIUM
B. D. Nash, T. T. Campbell, and F. E. Block Apr. 1968 21 p refs
(BM-RI-7112)

The object of this research was to investigate the technical feasibility of preparing chromium metal by the thermal decomposition of bisbenzene chromium. Bisbenzene chromium, a pi-bonded sandwich type organometallic compound, was thermally decomposed under reduced pressure to form a metal plate on a heated substrate. Metal recovery was close to 100% of theoretical, with deposition rates up to 20.8 mg/hr/cm^2. Metal purity was dependent not only upon the purity of the starting material, but also upon the sublimation rate of bisbenzene chromium. Total detectable metallic impurities ranged from a low of 18 ppm to several hundred ppm. In general, metallic impurities were less than 100 ppm. Carbon, the major nonmetallic impurity, ranged from less than 0.3% to more than 10%. The carbon contamination is most likely a result of the decomposition of the organic portion of bisbenzene chromium. An unusual property of some of the deposits was their outstanding corrosion resistance. Unlike pure electrolytic chromium, which dissolves readily, these deposits were insoluble in hot mineral acids. Author

N68-19584# Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics.
INVESTIGATION OF CONDENSED AQUEOUS SYSTEMS BY MOESSBAUER EFFECT
I. Dezsi, L. Keszthelyi, B. Molnar, and L. Pocs 1967 39 p refs
(KFKI-9/1967)

Solidified solutions of various ^{57}Fe ions in high spin state have been investigated by measuring their Mössbauer spectrum. The close values of the quadrupole splitting and the isomeric shift obtained at −191°C are an indication of the similar symmetries around these ions at this temperature. The temperature dependence of the Mössbauer parameters, namely, intensity, quadrupole splitting and line width, exhibits a remarkable change at about −90°C in the solid solutions under investigation except for that of Mohr salt for which this change occurs at −62°C. For the pure crystalline hydrates of dissolved iron salts no similar change takes place. The change in the temperature behavior suggests a structural transformation to occur at this temperature, probably recrystallization, involving a violent atomic diffusional motion. This conjecture is supported by the fact that the isothermal time behavior of the changes observed is similar to the S-shaped curve obtained by other methods for structural transformations. Author (NSA)

N68-19591# Technische Hochschule Munchen (West Germany).
INVESTIGATION OF HYDROGEN CHLORIDE ALPHA ELIMINATION IN CHLOROAMINES [UNTERSUCHUNGEN ZUR BASISCHEN ALPHA ELIMINIERUNG VON HYDROGENCHLORID AUS CHLORAMINEN]
Juergen Fischer (Ph.D. Thesis) 1967 118 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

In view of the successful application of physical methods for the extraction of nitrogen monohydride from chloramine, this study attempted to achieve a similar electron reduction in nitrogen by means of the chemical method of basic HCl-alpha elimination in solution. Discussed are the base effects on tertiary alkylhalogen amines and the basic hydrogen chloride elimination from chloramine. Experiments are described which involve tertiary alkylhalogen amines, chloramines and their higher chlorinated homologs, and the synthesis of authentic 2,2,3,3-tetramethyl ethylene imines. Transl. by K.W.

N68-19605 Texas Univ., Austin.
POSITRON LIFETIMES IN LITHIUM-AMMONIA SOLUTIONS AND METHODS OF DATA ANALYSIS
Reynaldo Morales (Ph.D. Thesis) 1967 186 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-8136

The lifetimes of positrons in lithium-ammonia solutions and in pure ammonia have been measured at a temperature of −65°C. The range of concentrations studied varied from 16.3 to 0.039 percent mole ratio of lithium to ammonia. The source of positrons was mixed in with the solutions and a correction was made for the annihilation of positrons in the glass walls of the sample cell. This correction was performed by subtracting from the measured data, a fraction of the lifetime spectrum of positrons annihilating in the glass walls of the sample cell with no solution present. After this correction was made, one mean life was found in the solutions with concentrations from 16.3% to 0.113%. Two mean lives were detected at a concentration of 0.078%, three mean lives at a concentration of 0.039% and two mean lives in pure ammonia. The data is interpreted in terms of one of the current models used in metal-ammonia work and in terms of a proposed model. Besides the method already mentioned for correcting for annihilations in the glass container, two other techniques are discussed.
Dissert. Abstr.

N68-19607# Technische Hochschule Munchen (West Germany).
GAS CHROMATOGRAPHIC INVESTIGATION OF REACTION PRODUCTS OBTAINED FROM THE UNION OF ISOMER TRANSFERS FROM ^{80m}Br to ^{80}Br IN LIQUID BENEZENE HALIDES [GASCHROMATOGRAPHISCHE UNTERSUCHUNGEN DER REAKTIONSPRODUKTE, DIE IM ANSCHLUSS

AN DEN ISOMERENUEBERGANG VON ^{80m}Br ZU ^{80}Br IN FLUESSIGEN HALOGENBENZOLEN ERHALTEN WERDEN]
Peter Schub (Ph.D. Thesis) [1967] 87 p refs In GERMAN

The isomeric transition from bromine 80m to bromine 80 was selected to study the reactivity of high-energetic atoms produced by nuclear reactions. A reaction outside of the radiative field was chosen to avoid any possible effects on, or modifications of, the particle interaction due to the radiation from the neutron source. Benzene and the benzene halides served as reaction media. The reaction products were separated by means of gas chromatography, and quantitative measurements were made to determine dependence on duration of reaction and bromine concentration. The reactions were studied in the absence of oxygen. A major finding was that a macroscopic exchange occurs, which shows that the exchange is not limited to primary excited atoms. The product distribution proceeds from fluor benzene to bromine benzene. The specific activities indicate that during exchange processes and in the formation of meta-disubstitution products, the primary hot atoms play the greatest role. Transl. by K.W.

N68-19621 European Organization for Nuclear Research, Geneva (Switzerland).
RADIOLYTIC CORROSION AND RELATED PROBLEMS IN THE COOLING WATER CIRCUITS OF HIGH-ENERGY PARTICLE ACCELERATORS
F. Hoyer, M. Bourges, and R. Deltenre Feb. 1968 24 p refs
(CERN-68-2)

Copper(II) ion production by radiolytic effects in the RF-cooling water circuit of the CERN 600 MeV Synchro-cyclotron was determined. Corrosion inhibitors, such as hydrazine and benzotriazole, were added to the water in a "circuit-simulator" and the corrosion rate under irradiation conditions was studied. Later, these inhibitors were directly applied to the water of the RF-cooling circuit and their behavior was examined. Beam intensity, water flow rate, available copper surface and temperature were kept constant and the dependence of copper(II) ion production on irradiation time was determined. Through this experiment it was possible to derive a law for the time dependence of the increase of copper(II) ion concentration. It could be shown too, that corrosion of copper surfaces in an irradiated water circuit follows a law which is different from that for "normal" corrosion in pure demineralized (but oxygen-containing) water. Benzotriazole, as an inhibitor, behaved as if the available copper surface had been reduced. For hydrazine, the inhibitive effect was disturbed by the quick copper catalyzed decomposition of this compound. Author

N68-19629 Oklahoma State Univ., Stillwater.
ABSORPTION BANDWIDTHS FOR CARBON DIOXIDE GAS
Charles Alfred Morgan, Jr. (Ph.D. Thesis) 1966 164 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-7263

Gas absorption bandwidths are required in the calculation by the band method of radiant exchange through an absorbing gas. In the present study spectral gas absorptance of carbon dioxide–nitrogen gas mixtures at various gas conditions was calculated and analyzed. From these studies, band absorption and bandwidths were determined. From these values an attempt was made to correlate band absorption and band absorption divided by bandwidth, for various bands at various gas temperatures, with gas properties. Band absorption and band absorption divided by bandwidth were satisfactorily correlated with gas conditions for carbon dioxide–nitrogen gas mixtures for four absorption bands at five gas temperatures. With these correlations it is possible to calculate absorption bandwidths suitable for use with the band method of radiant exchange calculations. Dissert. Abstr.

N68-19634# Joint Publications Research Service, Washington, D. C.
REGULATED GROWTH OF ORGANIC COMPOUNDS
2 Apr. 1968 15 p Transl. into ENGLISH from Orientirovannaya Kristillizatsiya (Moscow), 1964 p 144–158
(JPRS-44895) CFSTI: HC $3.00/MF $0.65

Published data on the oriented growth of one organic compound on another and on different minerals are reviewed. Consideration is given to the concept that the necessary conditions of epitaxy of organic compounds are their mutual tendency to form compounds; in this sense, epitaxy is a typical topochemical process of the formation of a two-dimensional molecule in the plane of contact between the precipitate with the substrate. Tables are presented to show the results obtained on oriented growths of several vapors and solid solutions of organic compounds capable of forming molecular compounds between themselves. Other examples of epitaxy as the result of chemical interaction are cited. Also reported are studies of the effect temperature has on oriented precipitations of crystals of organic compounds. M.G.J.

N68-19645 Oklahoma State Univ., Stillwater.
THE PHASE BEHAVIOR OF METHANE IN A NATURAL GAS CONDENSATE
Alto Nelson Stuckey, Jr. (Ph.D. Thesis) 1966 240 p
Available from Univ. Microfilms: HC $10.80/MF $3.10 Order No. 67-7298

Vapor–liquid equilibrium K-values and phase densities were obtained experimentally for a methane–Morrow condensate system at 150° and 250°F and pressures from 100 psia to the dew or critical points of the system at these temperatures using an experimental procedure that includes recirculation of the vapor phase by means of a magnetic pump. The data were evaluated by use of a thermodynamic consistency test and by comparison with existing K-value correlations. Correlation evaluation confirmed that the regular solution theory provides a convenient semi-empirical method for correlation of vapor–liquid equilibrium data. Dissert. Abstr.

N68-19669 National Inst. of Mental Health, Bethesda, Md. Translating Unit.
ELECTRON DISTRIBUTION IN CATIONS OF TRIARYLMETHANE DYES AND EXTRACTABILITY OF IONIC ASSOCIATES
S. A. Lomonosov 28 Jan. 1968 27 p refs Transl. into ENGLISH from Zh. Anal. Khim. (USSR), v. 22, no. 8, 1967 p 1125–1141

The influence of the electron distribution in component ions on the extractability of ionic associates with triarylmethane dyes is examined. An experimental study is made of the extraction of ionic associates of 13 triarylmethane dyes. One of the dyes was synthesized for the first time. The total magnitude of the positive charge on the region of association serves as the criterion of extractability. The region of the cation limited by the two most basic groups of the dye is responsible for the association. The efficiency of the outer structures with localization of the positive charge on these groups is greatest in an approximation of the qualitative method of valence structures. When the extraction is performed under conditions of elevated acidity of the aqueous phase or high values of its pH, the stability of the organic cations in the direction of protonization and association with anions of the medium or correspondingly in the direction of carbinolization can serve as a criterion of extractability. The concepts that are set forth show good agreement with the experimental findings reported in the literature. Author

N68-19671# Oak Ridge National Lab., Tenn.
X-RAY DIFFRACTION DATA ON THE SYSTEM CARBON TETRACHLORIDE NEOPENTANE AT 0°C
A. H. Narten Dec. 1967 27 p refs
(Contract W-7405-ENG-26)
(ORNL-4203) CFSTI: HC $3.00/MF $0.65

The diffraction pattern of an equimolar CCl_4–$C(CH_3)_4$ mixture in equilibrium with its vapor has been measured at 0°C. The diffractometer used was specially designed for the study of liquid structure. Both the raw data and the intensity and radial distribution functions derived from them are presented in tabulated form. Author (NSA)

N68-19737 Rutgers Univ., New Brunswick, N. J.
MOESSBAUER SPECTRA OF TIN HYDRIDE AND RELATED COMPOUNDS
George I. Parisi (Ph.D. Thesis) 1966 100 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8196

The Mössbauer spectra of SnH_4 and a number of its organic derivatives have been determined at 77°K. A systematic study of these compounds was conducted starting with tin hydride and successively followed by the complete families of methyl, *n*-butyl and phenyl tin hydrides. Di-*n*-butylchlorotin hydride, the only known example of an organotin compound with both chlorine and hydrogen linked to the same tin atom, and isopropyltin trihydride were also included. The compounds were prepared in the laboratory using appropriate synthetic procedures. Several related organotin chlorides were studied to aid in the interpretation of the results. The chemical identity and purity of the compounds prepared were established by means of infrared and nuclear magnetic resonance spectroscopy. These spectroscopic data which are presented are in good agreement with published values. Dissert. Abstr.

N68-19739 Washington Univ., Seattle.
KINETICS OF THE VAPOR-PHASE DEHYDRATION OF METHANOL AND ETHANOL CATALYZED BY CATION EXCHANGE RESINS
Bruce Clark Gates (Ph.D. Thesis) 1966 270 p
Available from Univ. Microfilms: HC $12.15/MF $3.50 Order No. 67-7642

The kinetics of the dehydration of methanol to dimethyl ether and ethanol to diethyl ether catalyzed in the vapor phase by the cation exchange resin Dowex 50 in the H^+ form were investigated. Differential conversion data were obtained with a packed-bed flow reactor and a gas chromatograph for analysis of products. Data were obtained at atmospheric pressure with methanol, methanol-argon, methanol-dimethyl ether, methanol-water, ethanol, and ethanol-argon feeds at 119.3°C; with methanol, methanol-water, and ethanol feeds at 99.3°C; and with methanol and ethanol feeds at 80.0°C. The results indicated that diffusional processes did not affect reaction rates. The approximate agreement of the adsorption constants in the Langmuir–Hinshelwood rate equation with independently obtained values and the identification of the rate-determining step indicated by independent experiments were interpreted as evidence of the general validity of the ideal reaction models. Dissert. Abstr.

N68-19748*# National Aeronautics and Space Administration, Washington, D. C.
HYDRATED CALCIUM PEROXIDES [SUR LES PEROXYDES DE CALCIUM HYDRATES]
De. Forcrand Mar. 1968 4 p Transl. into ENGLISH from Compt. Rend. Acad. Sci. (Paris), v. 80, no. 20, 1900 p 1308–1311
(NASA-TT-F-11620) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Four experiments were conducted on hydrated calcium peroxides and the resulting fluid was tested for its separability with varying numbers of filters, and the characteristics of the precipitate were compared. Extensive conclusions on the results are discussed, as is the author's object of future research. Author

N68-19780 Stanford Univ., Calif.
HIGH PRESSURE ELECTRON MAGNETIC RESONANCE IN SOLID ORGANIC FREE RADICALS
Robert Clark Hughes (Ph.D. Thesis) 1966 124 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-4370

A low field electron magnetic resonance spectrometer for operation at hydrostatic pressures up to 9 kbars is described. The pressure dependence of the exchange-narrowed triplet exciton magnetic resonance in $(\Phi_3PCH_3)^+$ $(TCNQ)_2^-$ and $(\Phi_3AsCH_3)^+$ $(TCNQ)_2^-$ has been observed at 170 Mc/sec in the ranges 1–9 kbar, and 220–362°K. pressure-induced phase transitions in these salts are reported. The observed p-T phase diagram for $(\Phi_3AsCH_3)^+$ $(TCNQ)_2^-$ can be explained remarkably well in terms of an elementary theory of non-interacting triplet excitons. A pressure-induced phase transition has also been observed in another triplet exciton crystal, Wurster's blue perchlorate. The observed p-T diagram can not be explained by changes in the spin system, because of the changes in the crystal structure in the transition. The pressure dependence of the EMR line width of several TCNQ salts and organic "antiferromagnets" is described in terms of the Anderson-Weiss theory of exchange-narrowing. Dissert. Abstr.

N68-19781 Rhode Island Univ., Kingston.
CATALYTIC OXIDATION OF METHANOL
John Thomas Cotter (Ph.D. Thesis) 1966 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-6985

A study of the rate of catalytic oxidation of methanol has been made in a fixed bed integral reactor. The molybdenum-iron oxide catalyst had an equivalent spherical diameter of 0.116 inch, a total surface area of 4.95 sq m/gm, a mean pore radius of 32 Å, and a total pore volume of 7.84×10^{-9} cu m/gm. The reactor effluent was absorbed in water and the conversion of methanol to formaldehyde was determined by the sodium bisulfite method. There was no evidence of any oxidation product such as carbon dioxide or carbon monoxide in the temperature range investigated. The catalytic oxidation of methanol was studied at an initial methanol concentration of 1–3 mole %, in the temperature range 495–635°F, and at a gas flow rate of 0.3 to 0.90 cu ft/min (at 77°F, 1 atm). Consideration of axial diffusion was found to have little influence on the predicted results. The same catalyst was used for approximately 40 days with no apparent change in activity. Dissert. Abstr.

N68-19783 Princeton Univ., N. J.
DIFFUSE FIRST ORDER PHASE TRANSITIONS
Nathan Harvey Canter (Ph.D. Thesis) 1966 162 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-5707

The phenomenon of diffuse phase transitions occurs very widely in simple inorganic and organic systems, such as the solid–solid transitions in ammonium chloride and in methane. It is known that in a finite temperature interval centered around the transition temperature, both the low temperature phase A and the high temperature phase B *coexist*. The most renowned manifestations of this phenomenon are the unusual specific heat curve (the lambda point anomaly), the appearance of X-ray lines of the two distinct phases A and B in the temperature interval of transition, and a gradual rather than discontinuous change of volume in the transition interval. A statistical thermodynamic model of the Ising type is developed which described all of these seemingly diverse phenomena in a unified and quantitative manner. The central feature of the theory is that it postulates the existence of a geometrically simple boundary phase (phase K) which coexists with phase A and phase B. Dissert. Abstr.

N68-19785*# Techtran Corp., Glen Burnie, Md.
SPECTROPHOTOMETRIC DETERMINATION OF TITANIUM IN FERRO-NIOBIUM WITH DIANTIPYRYLMETHANE
R. Kajiyama and K. Yamaguchi Washington NASA Mar. 1968 7 p refs Transl. into ENGLISH from Japan Analyst, v. 16, no. 9, 1967 p 908-912
(Contract NASw-1695)
(NASA-TT-F-11586) CFSTI: HC $3.00/MF $0.65 CSCL 07C

From 0.02 to 0.60% of titanium as an impurity in ferro-niobium was determined with diantipyrylmethane as a colorimetric reagent. With this reagent, however, niobium several hundred times as much as titanium did not interfere, provided that niobium had been previously converted to its oxalate. A sample was fused with potassium pyrosulfate, and digested into a sulfuric acid solution containing ammonium oxalate. An appropriate aliquot was taken out, and iron was reduced by adding ascorbic acid. Eight ml of hydrochloric acid (1+1) and 20 ml of the 1% reagent solution were added, and the whole volume was made up to 50 ml with water. The amount of titanium was obtained by the measurement of absorbency at 385 mμ after 45 minutes. Author

N68-19797 Michigan Univ., Ann Arbor.
THE QUANTUM CHEMISTRY OF ELECTRODE PROCESSES
Parbury Pollen Schmidt, Jr. (Ph.D. Thesis) 1966 197 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-1800

The purpose of this study is the formulation of a quantum mechanical theory of electrode processes based upon specific assumptions made concerning the nature of the electrode interface. Specifically, it is assumed that next to the electrode surface there is at least one layer of neutral adsorbed solvent molecules which exhibits an order resembling solid state order. Interspersed throughout the ordered layer of solvate molecules are the reactant ions. The process of charge transfer is assumed to be dependent directly upon orbitals of the solvate molecules. The transfer of an electron is assumed to proceed, first, by a transition from the electrode to the solvate molecule, and second, by a transition from the solvate molecule to the ion. For this model general conclusions are drawn concerning the rates of the electron transfers leading to the currents measured. Dissert. Abstr.

N68-19811# Naval Research Lab., Washington, D. C.
IDENTIFICATION AND CHARACTERIZATION OF ELECTROCHEMICAL REACTION PRODUCTS BY X-RAY DIFFRACTION Interim Report
Jeanne Burbank 20 Dec. 1967 25 p refs
(NRL-6626; AD-664945)

The application of x-ray diffraction methods to electrochemical studies is demonstrated by examination of the surfaces of polycrystalline solids by reflection diffractometry, operation of a cell designed for simultaneous x-ray and electrochemical studies, and the Berg-Barrett topographic technique. Silver anodes are used for illustrating the kind of information readily obtained by these methods: identity of crystalline reaction products associated with electrochemical phenomena, physical characterization of reaction mechanisms involving multiphasic coatings, distinction between large grains and preferred orientation, and estimations of coating thickness and crystal size. Author (TAB)

N68-19817# Army Chemical Center, Edgewood, Md.
SOME ASPECTS OF THE RADIATION CHEMISTRY OF THE TRICHLOROETHYLENE OXYGEN WATER SYSTEM
Ronald Sasse Jan. 1968 26 p refs
(NDL-TR-99; AD-664757)

The radiation chemistry of the trichloroethylene (TCE) system was investigated. G(H(+)) and G(Cl(-)) were determined as e(-)aq or OH, was scavenged with either hydrogen ion, ethanol, or phenol. These G values are given as functions of scavenger concentration. From this study it was shown that H. + TCE produces little if any Cl(-). It was also shown that G(H(+)) and G(Cl(-)) cannot be constants beyond 10 krad in oxygen-free solution whereas they are constants to higher doses in the presence of oxygen. Author (TAB)

N68-19818# Army Missile Command, Huntsville, Ala. Physical Sciences Lab.
PREPARATION OF SUBSTITUTED DIAZIRINES
William N. Knopka, Lawerence C. Robertson, and James A. Merritt 21 Nov. 1967 40 p refs
(RR-TR-67-17; AD-664768)

The preparation of a series of substituted diazirines, including those bearing deuterium substituents, is described. Product assignment was based on infrared and ultraviolet spectra together with mass spectrometric analyses. Author (TAB)

N68-19868# Naval Research Lab., Washington, D. C.
FEASIBILITY OF MICROSCOPY FOR INVESTIGATING THE SILVER OXIDE ELECTRODE Interim Report
C. P. Wales and A. C. Simon 9 Jan. 1968 30 p refs
(NRL-6647; AD-664993)

A study of the silver oxide electrode was made with the optical microscope, using methods that had previously proven successful for the lead-acid battery. It was determined that Ag, Ag2O, and AgO could be easily distinguished from one another in the polished section of the electrode without resorting to any etching or staining. Crystals of the three phases were also found to be of a size that made it feasible to follow crystallographic changes that occurred during the course of a discharge. Although considerable variations occurred in different areas of the same electrode, results were in agreement with previously obtained x-ray data. Author (TAB)

N68-19877 Michigan State Univ., East Lansing.
ELECTRON SPIN RESONANCE OF IRRADIATED ORGANIC SINGLE CRYSTALS
Lowell Donald Kispert (Ph.D. Thesis) 1966 257 p
Available from Univ. Microfilms: HC $11.70/MF $3.35 Order No. 67-7564

The π-electron radicals formed in several electron irradiated organic crystals were studied as a function of temperature. The radicals identified were: $\cdot CF_3$(77°K), $\cdot CF_2CONH_2$ (77–300°K) and $CONH_2$ (77°K) from trifluoroacetamide irradiated at 77°K. $\cdot CF_2COO^-$(300-77°K) from sodium chlorodifluoroacetate dihydrate irradiated at 300°K. $\cdot CH_3$ (77°K), CH_2COO^-(200°K) and $\cdot COO^-$(200–300°K) sodium acetate trihydrate irradiated at 77°K. $\cdot CF_2COO^-$(77°K) and various conformations of $\bar{O}OCCF_2CFCOO^-$(77–300°K) from sodium perfluorosuccinate hexahydrate irradiated at 77°K. $C_6H_5-COCHCOCF_3$(300°K) from benzoyltrifluoroacetone irradiated at 300°K and $\bar{O}OCCFCF_2CF_3$(300°K) from silver perfluorobutyrate irradiated at 300°K. Dissert. Abstr.

N68-19898 California Univ., Berkeley.
THE X-RAY CRYSTALLOGRAPHIC STRUCTURE DETERMINATION OF VARIOUS COMPOUNDS
Roger Clemens Pettersen (Ph.D. Thesis) 1966 54 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-5141

Using techniques of X-ray crystallography, the structures of three new chemical compounds have been determined. The first, tetramminediaquonickel (II) hexacyanoferrate (II), $[Ni-(NH_3)_4(H_2O)_2]_2$ $Fe(CN)_6$, crystallizes in space group R32 with hexagonal cell dimensions, $a = a_2 = 12.213$ A, $c = 17.005$ A, $\alpha = \beta = 90.00°$ and $\gamma = 120.00°$. The second structure is the para-bromo-aniline derivative of homo-cubane carboxylic acid.

This substance crystallizes in space group $P\bar{1}$ with cell dimensions, a = 10.092 A, b = 12.321 A, c = 11.649 A, α = 100.62°, β = 88.32° and γ = 114.10°. The third structure determined is ferricinium picrate, $C_{18}H_{12}N_3O_7Fe$. Dissert. Abstr.

N68-19901 Rensselaer Polytechnic Inst., Troy, N. Y.
THE CRYSTAL STRUCTURE OF YB_{66}
Stephanie Mellnik Richards (Ph.D. Thesis) 1966 227 p
Available from Univ. Microfilms: HC $10.35/MF $3.00 Order No. 67-4193

While the occurrence of unusual stoichiometries resulting from the presence of small percentages of the minor constituent are now recognized for a variety of binary phases, an extreme case was discovered in 1959 in the system yttrium-boron. This unusual phase required only 1-1 1/2% yttrium to form, corresponding to a probable range in composition of YB_{50} to YB_{100}. Subsequent to this preparation other systems were investigated and analogous boron rich phases were reported for Ho, Tb and Yb for Yb and Gd for Pu. Aside from the obvious interest in determining what stable configuration can exist at these unusual stoichiometries, the boron rich phases were reported for Ho, Tb and Yb, for Yb and Gd, and for Pu. Aside from the obvious interest in determining what of these materials are electron deficient. The outstanding feature of the structure is an icosahedral framework involving 1248 boron atoms arranged in eight thirteen icosahedral units of 156 atoms each. These units consist of a central icosahedron surrounded icosahedrally by twelve others. Dissert. Abstr.

N68-19911 Princeton Univ., N. J.
MEASUREMENT OF DOUBLE-LAYER CAPACITANCE IN THE PRESENCE OF A FARADAIC REACTION; SOME STUDIES OF THE PLATINUM-MERCURY INTERFACE
Gordon Daniel Robbins (Ph.D. Thesis) 1966 139 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-5745

A method is presented for determining double-layer capacitance in the presence of a simultaneously occurring Faradaic process. The circuit described applies a reversing current to the two working electrodes of a three electrode system causing the test electrode potential to vary between two preset values. The result is a triangular test electrode potential which can be preset, as can the constant rectangular current of amplitude. The circuit further ensures that the anodic and cathodic half-cycles are of equal duration. The compound formed at the platinum-mercury interface in mercury-coated platinum electrodes has been identified by X-ray diffraction as $PtHg_4$. It was found that all mercury is not removed from the compound by constant current anodic stripping or prolonged treatment in nitric acid. Formation of $PtHg_4$ and subsequent anodic stripping of the mercury from the compound leaves a highly developed platinum surface. Dissert. Abstr.

N68-19926 Iowa State Univ. of Science and Technology, Ames.
THE CRYSTAL STRUCTURES OF TRIPHENYL ALUMINUM AND LEAD(2) BROMIDE
Hollis Dean McBride (Ph.D. Thesis) 1966 89 p
(Contract W-7405-ENG-82)
(IS-T-100) Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-5605

The structures of two compounds, triphenyl aluminum and lead bromide, exhibiting electron deficient characteristics are reported. Triphenyl aluminum crystallizes in space group PT. There are two $Al(C_6H_5)_3$ monomers to the unit cell, and the density is 1.19 g/cc. The molecular structure is dimeric. $Al_2(C_6H_5)_6$. Two phenyl groups bridge between the aluminum atoms to form the dimer. The bonding is explained in terms of molecular orbital considerations including three-centered bonding orbitals contributing to the bridging bond to use all the available orbitals. Lead bromide crystallizes in space group Pnma. There are 4 molecules to the unit cell, all atoms being in special positions on the mirror. The structure exhibits both ionic and covalent bonding properties with nine-fold total coordination and three-fold primary covalent coordination about each lead. Bromine with two different properties exist, one part of a continuous chain of covalently bonded leads and bromines, and the other covalently bonded to only one lead. Dissert. Abstr.

N68-19927 New Mexico Univ., Albuquerque.
LUMINESCENCE OF SOME RUTHENIUM(2) AND OSMIUM(2) COMPLEXES
David Morris Klassen (Ph.D. Thesis) 1967 193 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-6239

Numerous coordination complexes of ruthenium(II) and osmium(II) have been prepared for spectroscopic studies. Complexes with 2,2'-bipyridine, 1,10-phenanthroline and 2,2'2"-tripyridine ligands having structures approaching octahedral microsymmetry about ruthenium(II) and osmium(II) ions have been prepared. Bis(bipyridine) complexes of ruthenium(II) with chloride, oxalate, cyanide, pyridine or ethylenediamine ligands substituted into the coordination sphere have also been prepared and studied spectroscopically. In addition, a few tetragonal complexes with diphosphine or diarsine ligands have been prepared with ruthenium(II) and osmium(II) ions. Ruthenocene was also synthesized for study. Dissert. Abstr.

N68-19928 Ohio State Univ., Columbus.
AN INVESTIGATION OF THE GAS-PHASE REACTION OF n-PENTANE WITH OXYGEN IN THE LOW TEMPERATURE REGION USING A CHEMICAL SHOCK TUBE
David Bruce Dahm (Ph.D. Thesis) 1966 178 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-6306

A detailed study of the formation of peroxides resulting from the reaction of n-pentane and oxygen was carried out in a chemical shock tube at reaction temperatures of 298°, 327°, 403°, and 435°C. and at reaction times in the range 1-3 milliseconds. The formation of the peroxides was determined as a function of time, reaction temperature, and mixture composition. The effect of added acetaldehyde on peroxide formation at 327°C. was also determined. Analyses for products other than peroxides and hydroperoxides were made at each reaction temperature. The results of the peroxide experiments suggest a cool flame type of mechanism for the peroxide appearance and disappearance. From the non-peroxidic product analysis, an initial attack by oxygen on pentane appears to occur at carbon atom two. The results obtained from all the experiments suggest strongly that the peroxy radical formed during the oxidation undergoes two simultaneous reactions: (1) hydroperoxide formation and (2) chain branching reactions forming other stable oxidation products such as crotonaldehyde. Dissert. Abstr.

N68-19933# Joint Publications Research Service, Washington, D. C.
THE REACTIONS OF PERFLUORONITROSOALKANES WITH THE ETHERS OF PHOSPHOROUS ACID
B. L. Dyatkin, E. P. Mochalina, Yu. S. Konstantinov, S. R. Sterlin, and I. L. Knunyants 22 Mar. 1968 12 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR (Moscow), 1967 p 2297–2305
(JPRS-44780) CFSTI: HC $3.00/MF $0.65

Depending on their structure, perfluoronitrosoalkanes react with triethylphosphite to form fluoro-containing phosphaso compounds, ethyl ethers of perfluoroketones, and oxides of perfluoronitriles. Results obtained agree with the concept of the basic attack of the

phosphite on a nitrogen atom of the nitroso group. Examples are given to show the chemical analogy of perfluoronitrosoalkanes and perfluoroketones. M.W.R.

N68-19945# Office of Naval Intelligence, Washington, D. C.
OXIDATION OF UNSATURATED COMPOUNDS BY ORGANIC PEROXIDES [OKISLENIYE NEPREDEL'NYK SOYEDINENIY ORGANICHESKIMI PEREKISYAMI]
N. Prilezhayeva 29 Jan. 1968 48 p refs Transl. into ENGLISH from Khim. Obshchestvo, (USSR), v. 44, 1912 p 613–647
(NIC-TRANS-2520; AD-664959)

Results are given of basic studies of the oxidation of both conjugated and nonconjugated dienes with benzoyl peroxide. TAB

N68-19946 Purdue Univ., Lafayette, Ind.
ATOMIC RADIAL DISTRIBUTION FUNCTIONS AND CORRELATION OF ATOM TYPES IN LIQUID AND AMORPHOUS BINARIES
Ernest Herman Henninger (Ph.S. Thesis) 1966 166 p
Available from Univ., Microfilms: HC $7.80/MF $3.00 Order No. 67-5441

X-ray diffraction patterns from liquid sodium-potassium alloy (NaK, 50 at. %), amorphous selenium, and vitreous silica (SiO_2) have been obtained and analyzed by Fourier inversion to determine the short range atomic order in these materials. In addition neutron diffraction patterns from these materials, were similarly analyzed. New correction techniques were applied which minimize errors and eliminate or reduce spurious detail in the radial distribution functions. With two different diffraction patterns it was possible to obtain a measure of the correlation of atom types in the short range order of the binary samples. For liquid NaK alloy the neutron data alone gave the true radial distribution and showed nearest neighbor concentrations at 4.4, 7.7, and 11.2 Å°. The results for vitreous SiO_2 clearly showed that the material is a randomly connected assemblage of SiO_4 tetrahedra. The independent analyses of the x-ray and neutron data from selenium gave intensity functions and radial distributions which agreed very well. Dissert. Abstr.

N68-19947 Ohio State Univ., Columbus.
PREPARATION AND STUDY OF SOME MANGANESE (1) CARBONYL COMPLEXES
Frederick Anthony Hartman (Ph.D. Thesis) 1966 85 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-6320

Methyl-, benzyl-, ethyl-, allylmanganese and methylrhenium pentacarbonyls react readily with liquid sulfur dioxide to yield the corresponding sulfinatopentacarbonyl complexes. The proton magnetic resonance spectra of the benzyl and ethyl complexes suggest that the manganese-sulfur-carbon attachments prevail in the $Mn\text{-}SO_2R$ moieties. The presence of a single absorption in the metal-sulfur stretching frequency region of the far-infrared spectra supports the above bonding assignment. The unusually low sulfur-oxygen stretching frequencies and the relatively high metal carbonyl stretching frequencies indicate strong manganese-sulfur π bonding. Furthermore, the patterns of the carbonyl stretching absorptions indicate that the structures of the manganese derivatives are appreciably distored from regular C_{4v} molecular symmetry. Dissert. Abstr.

N68-19958 California Univ., Berkeley.
SPECTROSCOPIC STUDIES OF REACTIONS OF LITHIUM ATOMS IN INERT GAS MATRICES
William Lester Self Andrews (Ph.D. Thesis) 1966 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-4992

The conventional double-dewar cryostat was modified to include a heater and Knudsen cell to serve as a lithium atom source. The matrix technique was extended to isolate the products of reactions of lithium atoms in inert gas matrices. Isolation of the incident lithium atoms increased with increasing matrix atomic weight and decreasing lithium atom concentration and decreasing deposition temperature as expected. These studies showed that dimerization of the incident atoms proceeds to a major extent except in very dilute samples in xenon deposited at 4°K. The lithium atomic absorptions showed multiplet structure in inert gas matrices. The multiplet components behaved independently of one another on sample warming. Non-nearest neighbor metal-metal atom interactions were investigated and found to be likely contributors to the observed spectral features. Dissert. Abstr.

N68-19963 National Inst. of Mental Health, Bethesda, Md. Translating Unit.
MERCURIMETRIC DETERMINATION OF THIOL ESTERS
Mieczyslaw Wronski 29 Jan. 1968 8 p refs Transl. into ENGLISH from Chem. Analityczna, (Poland), v. 11, no. 6, 1966 p 1153–1157

A method described for estimating thiol esters is based on the decomposition with dimethylamine and sodium hydroxide and titration of the resulting thiols with o-hydroxymercuribenzoate in the presence of dithiofluorescein. The formation and decomposition of the esters of dithiofluorescein was investigated. In the presence of triethylamine the thiol esters do not interfere with the titration of thiols. Author

N68-19967# Los Alamos Scientific Lab., N. Mex.
THE SEPARATION OF PLUTONIUM FROM PLATINUM BY COPRECIPITATION WITH FERRIC IRON FOLLOWED BY ION EXCHANGE ON INORGANIC EXCHANGE MATERIALS
G. L. Johnson and E. B. Fowler 12 Jul. 1967 8 p refs
(Contract W-7405-ENG-36)
(LA-3149) CFSTI: HC $3.00/MF $0.65

A method is described for the separation of trace amounts of plutonium from macro amounts of platinum. Platinum solutions, prepared from the metal contaminated with plutonium, are subjected to several scavengings with ferric ion. The resulting precipitates of hydrous ferric oxides are filtered and the final filtrate treated with hydrogen peroxide and nitric acid to reduce the plutonium to a form which will be retained by the ion exchange medium. Subsequent treatment by passage through a column of either ammonium molybdophosphate or zirconium phosphate serves to remove any residual plutonium remaining after coprecipitation with ferric ion. The method is rapid and efficient, giving high decontamination factors under the conditions studied. Author (NSA)

N68-19970# American Science and Engineering, Inc., Cambridge, Mass.
THE GROWTH OF SINGLE CRYSTALS OF THE CHARGE TRANSFER COMPLEXES Final Report, 1 Aug. 1964–30 Sep. 1967
Carolus M. Cobb and Elbridge B. Wallis 6 Nov. 1967 321 p refs
(Contract AF 19(628)-4239)
(ASE-1748; AFCRL-67-0635; AD-664895)

Single crystal preparation of the perylene iodine charge transfer compounds was investigated for melt growth, vapor phase growth, and solution growth techniques. A binary phase diagram showing the perylene iodine temperature and composition relationships was determined. The relationships between charge transfer composition, temperature, and iodine vapor pressure were measured by a gravimetric sorption, technique. Ternary plots of the solubility relationships at three temperatures for the perylene iodine compounds in chloroform are presented. Evidence for several species of solid perylene iodine complexes was obtained from phase studies. These are: P7(I2)10, P2(I2)3, P(I2)2, and P7(I2)20. A

method of single crystal growth of the P2(I2)3 complex from carbon disulfide solutions is described using an anti-wetting coating to prevent loss of supersaturation by precipitation on the walls of the growing chamber. Results from the program indicate that past and present difficulties in obtaining single crystals of these aromatic halogen charge transfer complexes from solution has been partly caused by lack of information about ternary solubility relations and partly from the tendency of solid materials of this type to wet the walls of the growth chambers. Author (TAB)

N68-19997# Aerospace Corp., El Segundo, Calif. Materials Science Lab.
PULSE RADIOLYSIS OF POLYSTYRENE
S. K. Ho, Seymour Siegel, and Harold A. Schwarz (Brookhaven Natl. Lab.) Oct. 1967 31 p refs
(Contract F04695-67-C-0158)
(TR-0158(3250-20)-1; SAMSO-TR-68-30; AD-664883)

The optical absorption spectra of the transient species produced by pulse electron radiolysis of polystyrene are reported. Polystyrene samples containing various aromatic solutes, as well as solute-free polystyrene samples, were examined. In solute-free polystyrene, the negative ion of polystyrene is observed. However, in samples containing triphenylamine as a solute, the solute positive ion is observed. The decay constants of the ion populations are of the order of milliseconds. In polystyrene samples containing aromatic solutes, the only new species observed are the corresponding solute triplet state molecules. Analysis of the data indicates that the energy transfer from host polymer to solute occurs by a random walk migration of singlet state excitation energy in the polymer. Solute triplet state molecules are formed by intramolecular intersystem crossing in the solute molecule. TAB

N68-20004# Naval Research Lab., Washington, D. C.
THE PLATE MATERIALS OF THE LEAD-ACID CELL. PART 3: ANODIC OXIDATION OF TETRAGONAL PBO
Final Report
Jeanne Burbank 29 Dec. 1967 24 p refs
(NRL-6613; AD-664827)

Tetragonal PbO (designated PbO-L) was anodized in H_2SO_4 solution at room temperature, and became converted to a dark-brown-to-metallic-black material resembling PbO_2. X-ray diffraction examination of the anodic product showed that it was neither of the known polymorphs of PbO_2 but had retained the diffraction pattern of the original tetragonal PbO. The oxidized material had many of the chemical properties of PbO_2, an ohmic resistivity of 0.82 ohm-cm, and an open circuit potential in 1.225 sp gr H_2SO_4, 52 mv above that of beta-PbO_2 in the same acid. Chemical analysis showed a stoichiometry of PbO1.91. Crystal morphologies were examined in the electron microscope. Studies on the mechanism of PbO-L oxidation indicate that oxygen may enter the PbO-L lattice as atoms, take two electrons from the Pb present in the lattice and then diffuse through the lattice as ions. Two possibilities for the logical placements of the additional oxygen in the lattice are the fluorite-related LaOF and the PbFC1 layer structure types, both with the same space group as PbO-L, P4/nmm. It is not possible at this time to determine which if either of these possibilities is the actual structure. Author (TAB)

N68-20008*# Aztec School of Languages, Inc., Acton, Mass.
OVERTENSION AND INTERFACIAL CHEMISTRY [UEBERSPANNUNG UND GRENZFLAECHENCHEMIE]
Konrad Gossner (Ph.D. Thesis—Munich Univ.) Washington NASA Mar. 1968 109 p refs
(Contract NASw-1692)
(NASA-TT-F-11543) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Heterogeneous processes and contact effect parameters are considered in a thesis dealing with overtension and interfacial chemistry that details the contact chemical bases of the electrolytic dissociation of hydrogen as well as hydrogen overtension in various metals and alloys. Chapters in the part on chemical bases are entitled Hydrogen Overtension, Electrode Potentials, Overtension and Contact Specificity, and Reproducible Overtension Measurement. The relationships developed in these sections are applied, and the findings presented offer data that are primarily applicable to the electron structure of the contacts. A method for estimating possible extreme values of absolute potentials is discussed. M.W.R.

N68-20012*# Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.
ELECTROCHEMICAL CHARACTERIZATION OF NONAQUEOUS SYSTEMS FOR SECONDARY BATTERY APPLICATION
Quarterly Report, Nov. 1967–Jan. 1968
M. Shaw, O. A. Paez, A. H. Remanick, and D. A. Lufkin 16 Feb. 1968 90 p refs
(Contract NAS3-8509)
(NASA-CR-72377; QR-7) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Multisweep cyclic voltammograms have now been obtained for over 950 systems comprising silver, copper, nickel, cobalt, zinc, cadmium, molybdenum, indium, iron, vanadium, chromium, and manganese electrodes in acetonitrile, butyrolactone, dimethylformamide, and propylene carbonate solutions of chlorides, perchlorates, and fluorides. This completes the screening of the positive plate-electrolyte combinations. Twenty-four systems are recommended on the basis of their electrochemical characteristics at the molecular level of the electrode reaction. Author

N68-20020# Rocketdyne, Canoga Park, Calif. Research Div.
SENSITIVITY OF METAL-HALOGENATED SOLVENT COMBINATIONS
G. D. Artz and C. B. Fingerhood 1967 11 p Presented at Interagency Chem. Rocket Propulsion Group Meeting, Hazards Working Group, El Paso, Tex., 5 Dec. 1967
(AD-665057)

A program is described which was conducted to determine how sensitive to impact various metal/halocarbon slurries are, and to determine, if possible, if a potential hazard (due to impact) exists in the handling of more common powdered or granular metals in contact with a variety of commonly used halogenated solvents. Ten different kinds of metallic powders of granules were tested with six different solvents. TAB

N68-20021 Illinois Univ., Urbana.
NUCLEAR MAGNETIC RESONANCE STUDIES OF ORGANOMETALLIC EXCHANGE REACTIONS
Larry Max Seitz (Ph.D. Thesis) 1966 141 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-6728

Lithium-7 and proton NMR were employed to study exchange reactions in ether solutions of (a) organolithium compounds and (b) $RLi–MR_2$ where R = CH_3– or C_6H_5 and M = Mg or Zn. Proton and ^7Li spectra of methyllithium and ethyllithium were observed in the temperature range from 30° to −80° C. Methyllithium-phenyllithium and ethyllithium-phenyllithium mixtures were examined at low temperature by proton and lithium-7 NMR, respectively. A methyllithium solution enriched in ^6Li was examined by ^7Li NMR at low temperature. No $^7Li–^6Li$ spin–spin coupling was observed. Proton and ^7Li spectra of ether solutions of methyllithium with dimethylmagnesium and dimethylzinc were examined over a large temperature range. Proton and ^7Li spectra of ether solutions of phenyllithium with diphenylmagnesium and diphenylzinc were examined over a large temperature range. The $CH_3Li–Mg(C_6H_5)_2$ and $C_6H_5Li–Mg(CH_3)_2$ systems were examined at low temperature by proton and Li^7 spectra. Dissert. Abstr.

N68-20037 Illinois Univ., Urbana.
THE ELECTROCHEMICAL BEHAVIOR OF SELECTED AROMATIC NITROCOMPOUNDS IN UNBUFFERED SOLUTIONS
Charles Taft Baker (Ph.D. Thesis) 1966 151 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-6547

An investigation of the polarographic behavior of o-nitro-benzoic acid, m-nitrobenzonitrile, and m-chloronitrobenzene in buffered solution showed that a polarographic split wave is exhibited in the alkaline solutions (pH 8–12). In the pH region where the split wave was observed, as the pH increased, the limiting current of the first wave decreased while the height of the total wave remained constant. It was established that this first wave of the polarographic split wave is partially kinetically controlled. The behavior in buffers of different charge type showed that the kinetic influence exerted by the buffer on the reduction is due either to (1) the rate at which the particular buffer system can supply hydronium ion at the electrode surface or (2) the rate at which the buffer itself can transfer protons to an intermediate. Unbuffered solutions of m-nitrobenzonitrile and m-chloronitrobenzene exhibited the polarographic split wave in the pH region from 3 to 4. Dissert. Abstr.

N68-20038 Illinois Univ., Urbana.
DYNAMIC PROTON POLARIZATION IN SOME RARE EARTH ETHYL SULPHATES
David Strand Wollan (Ph.D. Thesis) 1966 164 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-6778

Measurements of the dynamic polarization of protons by the solid state effect have been made at liquid helium temperatures on single crystals of erbium-doped and neodymium-doped yttrium ethyl sulphate (Er, Y)ES and (Nd, Y)ES). The dynamic polarization was induced by saturating the forbidden, satellite electron spin resonance (ESR) line of the paramagnetic ion, and was measured by comparing proton nuclear magnetic resonance (NMR) signals. Because of its higher hydrogen density, it was hoped that YES might be a better material than the commonly-used lanthanum magnesium nitrate (LaMN) for use as a polarized proton target for nuclear scattering experiments. Preliminary results on (Er, Y)ES at 9.5 Gc/sec showed several features that prohibit high proton polarizations. An anomalous behavior was observed in (Er, Y)ES at 2.0°K due to the overlap of one of the Er^{167} hyperfine lines with the main ESR transition. Preliminary experiments on (Nd, Y)ES at 9.5 Gc/sec indicated that this system was favorable for high polariztions. Dissert. Abstr.

N68-20040 North Carolina Univ., Chapel Hill.
A LIGHT-SCATTERING STUDY OF HYDROLYTIC POLYMERIZATION OF ALUMINUM IN AQUEOUS PERCHLORATE MEDIA
Joseph Higgins Patterson (Ph.D. Thesis) 1966 201 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-5360

A light-scattering investigation of the polymerization of aluminum (III) was carried out for hydroxyl numbers (average number of bound hydroxyl ions per aluminum) 1.00, 2.00, 2.25, 2.35, and 2.40. Aluminum concentration was varied over a ten fold range. Each solution contained a one molar sodium perchlorate supporting electrolyte. The densities, turbidities, and refractive index increments ($\Delta n/c$) of each solution were determined. From these data weight average degrees of polymerization were calculated. The results indicate the degree of polymerization is a continuous function of the hydroxyl number varying from two aluminum atoms per aggregate at hydroxyl number 1.00 to seven aluminum atoms per aggregate at the higher hydroxyl numbers. Appreciable perchlorate complexing is indicated. The degree of aggregation is also found to be partially dependent upon the time allowed for and the temperature of the hydrolysis reaction. Dissert. Abstr.

N68-20052 Pennsylvania State Univ., University Park.
OXYGEN-18 TRACER AND LOW TEMPERATURE CHEMISORPTION STUDIES OF THE CARBON–OXYGEN REACTION
Peter Joseph Hart (Ph.D. Thesis) 1966 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-5921

Various aspects of the mechanism of the carbon–oxygen reaction were studied at oxygen pressures between one and 50 millitorr and at reaction temperatures from 25° to 555°C. The carbon material used in these studies was Graphon, Spheron 6 carbon black, which had been graphitized at 2700°C. The carbon surface was cleaned, and adsorbed gases were removed, by heating the sample to 950° to 975°C in a vacuum of about 10^{-8} torr. The partial pressures of the gaseous species involved in the reaction were measured with a mass spectrometer. One of the products of the interaction of carbon and oxygen is a surface oxide which is stable at its temperature of formation. The behavior of this oxide was followed, during oxidation of the carbon, by tagging it with O^{18}. It was found that this oxide was not the intermediate in the formation of the gaseous carbon monoxide and carbon dioxide species. Dissert. Abstr.

N68-20058# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Munich (West Germany). Institut fuer Flugtreib und Schmierstoffe.
CHEMICAL REACTIONS OCCURRING IN FIRE FIGHTING WITH THE AID OF HALONES [UEBER CHEMISCHE VORGAENGE BEI DER BRANDBEKAEMPFUNG MIT HALONEN]
J. Kern Jan. 1968 55 p refs In GERMAN; ENGLISH summary (DLR-FB-68-04; DVL-701) CFSTI: HC $3.00/MF $0.65

The decomposition reactions of halogenated methanes used in fighting aircraft fires are discussed. Pyrolysis experiments were conducted with CH_2ClBr, CF_2ClBr, CF_2Br_2, and CF_3Br in the absence of air, in the presence of oxygen, in reducing atmospheres, and in contact with metal. The decomposition mechanism and inhibitory effects were identified. It was found that bromine or chlorine and the corresponding hydrohalogenides are the decomposition products effective in fire extinguishing. K.W.

N68-20072 Maryland Univ., College Park.
STUDIES OF FLUORESCENCE SPECTRA WITH A MINIATURIZED HIGH PRESSURE CELL
Mitchell Arthur Thiel (Ph.D. Thesis) 1966 133 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-6151

Commercial fluorescence spectrophotometers are not suited for use with high pressure cells because of the small sample size and the geometry of high pressure cells. A Perkin–Elmer Model 350 Recording Spectrophotometer has been modified to function as a spectrofluorometer for use with the diamond high pressure cell. An Osram 150 watt xenon arc is used as the ultraviolet excitation source. The ultraviolet radiation is isolated by an auxiliary monochromator and filters. Microscope long-working distance objectives are used to focus on the diamond window of the cell and pick up the fluorescence emission. The spectral range of the modified instrument is from 405 to 750 mμ. The instrument has adequate sensitivity and resolution for the study of pressure effects in the fluorescence spectra of aromatic hydrocarbons, both in the solid state and in solutions. Dissert. Abstr.

N68-20081 Connecticut Univ., Storrs.
FREQUENCY RESPONSE OF A PACKED DISTILLATION COLUMN
George Harold Knepple (Ph.D. Thesis) 1966 70 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-3892

The frequency response of a packed distillation column operated at total reflux was investigated experimentally. The output–input relationship studied was the vapor temperature-reflux flow rate relationship of the benzene–toluene binary system. The Bode diagrams of the frequency response data show that the frequency response is underdamped second order. The dynamic parameters of the second order frequency response were studied for correlations with static and steady state parameters. The damping coefficient was found to be constant at an average value of 0.567. The natural frequency was correlated with the number of over-all vapor phase distillation transfer units. Dissert. Abstr.

N68-20093*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
TECHNIQUE FOR DETERMINING GASES DISSOLVED IN FUELS, OXIDIZERS, AND LIQUIDS IN GENERAL
Stephen P. Vango 1 Apr. 1968 9 p ref
(Contract NAS7-100)
(NASA-CR-93791; JPL-TR-32-1236) CFSTI: HC $3.00/MF $0.65 CSCL 07D

A simple, direct method is described for determining the dissolved pressuring gases in oxidizers and fuels. The method consists in pumping the gases from repetitively frozen samples, measuring the volume manometrically, and sampling the collected gases for analysis. Author

N68-20095 Virginia Polytechnic Inst., Blacksburg.
AN EVALUATION OF THE STIFFNESS OF MACROMOLECULES
Donald Wayne Monk (Ph.D. Thesis) 1967 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-6227

The relative stiffness of polymer chains was evaluated, and the rate of change of the dimensions of polymer coils with changing second virial coefficient was determined. The change in the dimensions of the polymer coil for a given change in the second virial coefficient was taken as a measure of the stiffness of the coil. The Z-average radii of gyration were measured as functions of the second virial coefficient for polyisobutylene, polystyrene, and polymethacrylonitrile at constant temperature by standard light scattering techniques. Changes in the radius of gyration and the second virial coefficient were brought about by varying the concentration of nonsolvent in solvent-nonsolvent mixtures. When values of the second virial coefficient were plotted against the fractional change in the volume of the polymer coil, a linear relation was found for each polymer. Dissert. Abstr.

N68-20099 North Carolina Univ., Chapel Hill.
ELECTROCHEMICAL STUDIES OF THE BENZIDINE REARRANGEMENT; THE DEVELOPMENT AND APPLICATION OF AN ELECTROLYSIS CELL FOR ELECTROCHEMICAL STUDIES OF SMALL SOLUTION THICKNESSES
Donald Mc Clain Oglesby (Ph.D. Thesis) 1966 162 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-5357

Theory for the reverse-ramp current function is presented for the chronopotentiometric study of a reversible, non-kinetic system and for a system having a first-order reaction following electrogeneration. The theory for the non-kinetic case was verified on the ferri-ferrocyanide system and the theory for the first-order following kinetic case was verified using the acid catalyzed, pseudo-first-order rearrangement of electrochemically generated hydrazobenzene. The first-order rate constants in 35.5% ethanol-water solution having perchloric acid concentrations ranging from 0.175 M to 0.25 M were determined by both reverse-ramp chronopotentiometry and step-current reversal chronopotentiometry. A new, versatile electrode design suitable for thin-layer electrochemical studies was developed, and its accuracy and practicality were verified. The use of both platinum metal and mercury-coated platinum as working electrode materials is discussed. Dissert. Abstr.

N68-20100 Ohio State Univ., Columbus.
HYDRODYNAMIC AND QUIET SOLUTION VOLTAMMETRY AT TUBULAR MERCURY-FILM ELECTRODES
Thomas Ovid Oesterling (Ph.D. Thesis) 1966 189 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-6352

One-half inch lengths of 0.060" i.d. seamless platinum tubes were heat-sealed into soft glass tubing of about the same inside diameter. Mercury films were placed on the inside of the tubular electrodes by placing metallic mercury in contact with the platinum surface after pretreatment with hydrogen evolution in perchloric acid media. Assuming uniform distribution of mercury, film thicknesses ranged from 4 to 14 microns as determined by dithizone extraction. The cathodic limit of usefulness (less than one microamp. current) was about −1.2 volt vs. SCE with 0.1 M KNO_3 flowing through the mercury-film tubular platinum electrode (MTPE) at 3 ml./min. and became more anodic with decreasing pH. The anodic limit was about 0.4 volt in 0.1 M KNO_3 and 0.5 M H_2SO_4, and about 0 volt in chloride media. An equation was derived to express the relationship between current, potential and other experimental parameters during an ion-amalgam reduction at the MTPE, assuming Nernstian behavior and conservation of mass at the electrode surface. Dissert. Abstr.

N68-20103 Iowa State Univ. of Science and Technology, Ames.
A STUDY OF THE SURFACE REACTIONS OF HYDROCARBONS ON TUNGSTEN BY FIELD ELECTRON EMISSION MICROSCOPY
Nelson Craig Gardner (Ph.D. Thesis) 1966 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-5587

The chemisorption and surface reactions of acetylene and ethylene on tungsten surfaces were studied by field electron emission microscopy. Acethylene chemisorbed associatively on tungsten at temperatures below 300°K. At higher temperatures, decomposition reactions occurred and were monitored by measuring the surface work function change. From shadowing experiments, it was confirmed the chemisorbed acetylene and ethylene are immobile. However, at temperatures between 70°K and 100°K, Type I diffusion was observed. It was deduced that acetylene chemisorbs "cis," with the tungsten carbon atoms coplanar, on the short 2.74Å and 3.16Å spacings available on a tungsten lattice. Ethylene was found to chemisorb on the long 4.47Å spacings available principally on the 112 and 111 planes of tungsten. It was proposed that ethylene chemisorbed "trans" to accommodate the long spacing. Dissert. Abstr.

N68-20110 Columbia Univ., New York.
PART 1: STUDIES ON SPIN RELAXATION IN OPTICALLY PUMPED RUBIDIUM. PART 2: THE USE OF OPTICAL PUMPING TO DETECT FREE RADICALS IN THE PHOTOLYSIS OF THE SIMPLE ALKANES
David Risdon Crosley (Ph.D. Thesis) 1966 89 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-5769

The process of buffer gas disorientation of an optically pumped alkali metal, in the absence of the pumping radiation, is treated by a density matrix method. The electron spin randomization model is used for a nuclear spin of 3/2 and 5/2 (e.g., rubidium). Combining this with uniform relaxation at the walls leads to a model for the relaxation in terms of a sum of exponentials. Each of these is related to the diffusion coefficient and the disorientation cross section by an amount dependent on the pressure of buffer gas. An optically pumped system of rubidium has been used as a probe to measure the concentration of free radicals present during the vacuum ultraviolet photolysis of five hydrocarbons. The mechanism for this measurement is the large spin exchange interaction of a molecular radical with the optically pumped alkali. Because of experimental and analytical difficulties, absolute quantum yields for radical production cannot be given. Dissert. Abstr.

N68-20111 Illinois Univ., Urbana.
NUCLEAR SPIN RELAXATION IN LIQUIDS
Fu-Ming Chen (Ph.D. Thesis) 1966 97 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-6583

Three topics concerned with nuclear spin relaxation in liquids have been investigated. The first part considers cross correlation effects among various dipolar pairs in a system with three identical spin-1/2 nuclei located at the corners of an equilateral triangle and rotating about the C_3 symmetry axis of the group. The spin group is part of a molecule which is undergoing isotropic rotational motion. The second part deals with nuclear relaxation time measurements as a function of temperature for benzotrifluoride and its ortho, meta and para halogen substituted derivatives. Fluorine and proton T_1's are reported for the pure compounds as well as for solutions at several concentrations in carbon disulfide. The third part treats various methods for calculating the correlation time for molecular reorientation. Numerical calculations are made for the ammonia molecule and the calculated values are compared with values inferred from experiment. Dissert. Abstr.

N68-20112 Iowa State Univ. of Science and Technology, Ames.
HYDROLYSIS PRODUCTS OF RARE EARTH SILICIDES
Dale Dean Clyde (Ph.D. Thesis) 1966 104 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-5574

The silicides, La_5Si_3, Ce_5Si_3, Pr_5Si_3, Nd_5Si_3, Gd_5Si_3, Dy_5Si_3 and Er_5Si_3, were prepared by direct combination of the elements in an arc melter under an atmosphere of argon. They were hydrolyzed with 8 N H_3PO_4. In all of the reactions monosilane (95 mole percent or more) and disilane (5 mole percent or less) were produced. Trisilane was formed by the hydrolysis of La_5Si_3, Ce_5Si_3 and Nd_5Si_3 but it was not observed for the hydrolysis of Pr_5Si_3, Dy_5Si_3, Gd_5Si_3 and Er_5Si_3. The hydrolytic reactions for Ce_5Si_3 were studied as a function of the acid concentration. When Ce_5Si_3 was hydrolyzed with water, 2 N, 8 N or 10 N H_3PO_4, only monosilane and disilane were formed. For 4 N and 6 N H_3PO_4, trisilane was also observed. The values for the relative molar responses for monosilane and disilane were 52.7±5.6 and 105.5±12.2, respectively (benzene = 100). The relative molar response for trisilane was estimated from the relative molar responses of monosilane and disilane to be 159. Dissert. Abstr.

N68-20113 Rutgers Univ., New Brunswick, N. J.
INTERACTIONS AT SOLID SURFACES. PART 1: SORPTION OF HYDROGEN AND OXYGEN ON ZINC SULFIDE POWDER. PART 2: INTERACTION OF OLEIC ACID WITH COPPER SURFACES
Kenneth Henry Brown (Ph.D. Thesis) 1966 189 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-5258

In part I the kinetic behavior of hydrogen and oxygen sorption on zinc sulfide was studied and a mechanism proposed. The rate was determined from the volumetric measurement of the amount sorbed in a constant volume system. Increased rate and amount of sorption occurred during experiments with extraneous energy supplied to the system from an ultraviolet lamp or a Tesla coil. B.E.T. surface area determinations indicated no large changes occurred during the sorptions. In Part II the interaction between between oleic acid and a slightly oxidized copper surface was investigated spectrophotometrically. Absorption, emission, and reflection spectra in the infrared region were employed. The work concentrated on the spectral range from 1500 cm^{-1} to 1000 cm^{-1}, because the emission intensity is at its maximum in the region at 150°C and because the interaction involves C–O bonds whose vibrations are in this region. Dissert. Abstr.

N68-20114 Illinois Univ., Urbana.
ROTATION IN THE SOLID STATE: A STUDY OF HYDROGEN AND DEUTERIUM HALIDES IN RARE-GAS MATRICES
Michael Thomas Bowers (Ph.D. Thesis) 1966 147 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-6565

Experiments on HF, HCl, DCl, HBr, DBr and HI isolated in rare-gas, N_2 and rare-gas plus N_2 lattices have been performed. Concentration and temperature dependent studies yielded the monomer spectra. All of the hydrogen and deuterium halides performed hindered rotational motion in the solid rare gases. None of these species rotated in the N_2 matrix. The addition of a few per cent N_2 into the rare-gas systems produced a new site for the molecules, in addition to the rotational site. Rotation was quenched in this new site. In addition to the rotational effects, monomeric molecules gave rise to three vibrational effects: 1) absorptions due to molecules in sites with impurity n.n., 2) absorptions due to molecules in interstitial sites, and 3) a red shift of the fundamental vibration of the rotating molecules. In addition to the monomer effects, dimer and higher polymer spectra were recorded. Dissert. Abstr.

N68-20117 Rensselaer Polytechnic Inst., Troy, N. Y.
ADSORPTION OF KRYPTON ON ANNEALED PYROLYTIC GRAPHITE AT PRESSURES BETWEEN 10^{-10} AND 10^{-6} TORR
Lee Bernhardt Harris (Ph.D. Thesis) 1966 194 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-4170

A modification of the "flash filament" technique was used to measure the adsorption isotherms of krypton on highly annealed pyrolytic graphite at pressures between 10^{-10} and 10^{-6} torr at liquid-nitrogen and liquid-oxygen temperatures. The graphite surface was also studied by means of electron microscopy. The isosteric heats of adsorption vary from 5.6 to 3.5 K cal./mole over the range of pressures investigated and are described by means of a model of interlamellar adsoprtion suggested by the electron microscope results. An approximation method for treating adsorption data on heterogeneous surfaces is presented and analyzed. The method simplifies the determination of surface heterogeneity and also permits the calculation of approximate theoretical heats of adsorption on a heterogeneous surface vs. the pressure at which the heat is measured, starting with a model such as the two-dimensional van der Waals gas. The present experimental isosteric heats of adsorption on pyrolytic graphite and isosteric heats at low pressure obtained by other investigators are compared with the approximate theoretical heats. Dissert. Abstr.

N68-20118 Illinois Univ., Urbana.
QUANTITATIVE ANALYSIS OF SOLUTIONS AND SOLIDS AND THE IDENTIFICATION OF IONIZATION LEVELS BY SUBMICROSECOND TIME-RESOLVED SPARK EMISSION SPECTROSCOPY

Ramon Murray Barnes (Ph.D. Thesis) 1966 282 p
Available from Univ. Microfilms: HC $11.95/MF $3.40 Order No. 67-6552

Submicrosecond time-resolved emission spectroscopic measurements from an analytically useful spark discharge have resulted in the discovery of correlations between solution and solid sampling methods. The results provided insight for the development of new analytical methods. A method has been developed utilizing submicrosecond time-resolved spectroscopy to identify ionization states in the spark, and to select and sort emission lines from the sample or counter electrodes and the atmosphere. Matrix effects have been studied by short-time observations, and improved quantitative results using a semi-conductor diode to shunt the spark gap have been demonstrated. An improved electrode material transport method has been proposed and tested. Dissert. Abstr.

N68-20126 California Inst. of Tech., Pasadena.
ELECTROCHEMISTRY IN THIN LAYERS OF SOLUTION
Arthur Thornton Hubbard (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-6066

New electrodes for electrochemistry in thin layers of solution have been constructed which are easier to use and give more reproducible data than previous designs. The theory of voltammetry, chronopotentiometry and chronocoulometry in thin layers is derived and verified for simple systems using these electrodes. The extent of adsorption of the I_2–I^-, CoY^-–CoY^{-2} and FeY^-–FeY^{-2} couples (H_4Y = ethylenediaminetetraacetic acid) at platinum electrodes has been determined. About 2×10^{-9} mole/cm.^{2} of iodide ion or 2×10^{-9} mole/cm.^{2} iodine were shown to be adsorbed in a non-electroactive state. An additional 1×10^{-9} mole/cm.^{2} of iodine but no iodide was adsorbed in an electroactive state. About 3.1×10^{-10} mole/cm.^{2} of CoY^- or 4.7×10^{-10} mole/cm.^{2} of CoY^{-2} are adsorbed at bright platinum electrodes. No adsorption of FeY^- or FeY^{-2} was detected. Dissert. Abstr.

N68-20129# Massachusetts Univ., Amherst. Chemistry Dept.
INFRARED DICHROISM OF ORIENTED DEHYDROCHLORINATED POLYVINYL CHLORIDE
Richard S. Stein, Yohji Shindo, and Bryan E. Read Dec. 1967 25 p refs Supported in part by NSF and Am. Chem. Soc.
(Contract Nonr-3357(01))
(ONR-TR-95; AD-664953)

The infrared dichroism of oriented dehydrochlorinated polyvinyl chloride is studied as a function of percent elongation values of the orientation function of the polymer, are calculated from dichroism values, and compared with orientation functions obtained from ultraviolet dichroism. It was found that the infrared determined orientation function depends upon the band being studied. This effect is attributed to the dependence of infrared absorption upon chain conformation. Author (TAB)

N68-20171 North Carolina Univ., Chapel Hill.
A GENERAL THEORY OF ELECTROCHEMICAL RELAXATION TECHNIQUES INVOLVING MULTIPLE (PSEUDO-) FIRST ORDER CHEMICAL REACTION STEPS AND LINEAR DIFFUSION AT A PLANAR ELECTRODE. APPLICATIONS OF THE LINEAR SUPERPOSITION PRINCIPLE TO GAS CHROMATOGRAPHY. THE NUCLEAR (PROTON) MAGNETIC RESONANCE SPECTRA OF ETHYLENEDIAMINETETRAACETATE COMPLEXES WITH ALUMINUM(III) IN AQUEOUS SOLUTION
Johnson Wells Ashley, Jr. (Ph.D. Thesis) 1966 183 p
Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-5325

A general treatment is given for electrochemical processes involving (pseudo-) first-order chemical reactions and semi-infinite planar diffusion. The physical implication of a derived general equation relating surface concentration and currents—which are time dependent functions—are discussed. A linear superposition principle coupled with the use of Laplace transformation is employed to develop a general relationship between gas chromatographic sample input and response shapes. This leads to the prediction of many interesting response shapes, thus not only broadening the scope of gas chromatographic techniques but also affording a basis for direct comparison of experimental parameters obtained by the different techniques. Nuclear magnetic resonance spectra of aqueous solution of Al(III) and ethylenediaminetetraacetic acid in various ratios have been obtained for the pH range 4.4 to 8.5. Interpretations of these spectra indicate that, contrary to a previous report from another laboratory, the complex species do not undergo rapid metal exchange. Dissert. Abstr.

N68-20194*# Case Western Reserve Univ., Cleveland, Ohio.
A METHOD OF SOLVING SETS OF NONLINEAR ALGEBRAIC EQUATIONS Progress Report
R. J. Adler and S. Y. Ku 10 Mar. 1968 16 p refs
(Grant NGR-36-003-021)
(NASA-CR-93822; PR-5) CFSTI: HC $3.00/MF $0.65 CSCL 07D

The second generation computer program being developed as part of this research program has been applied to a problem from the field of nuclear magnetic resonance spectroscopy. The program incorporates the supplementary techniques of partitioning and some limited forms of factoring together with an improved algorithm for eliminating polynomial variables. The problem solved consisted of five multivariate polynomial equations, four nonlinear and one linear, in five variables. Twelve real solutions, which are permulations of two "true solutions," were shown to exist. The problem illustrates the capabilities of the second generation program and the usefulness of supplementary techniques. Author

N68-20217 Illinois Univ., Urbana.
HEAT CAPACITIES OF THREE MAGNETIC SALTS NEAR THEIR CRITICAL POINTS
Martin Rayl (Ph.D. Thesis) 1966 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-6708

Low temperature heat capacity measurements have been made near the λ-type anomalies of $Mn(NH_4)_2(SO_4)_2 \cdot 6H_2O$, $K_3Fe(CN)_6$, and $CuK_2(SO_4)_2 \cdot 6H_2O$. A method of determining the critical point T_λ from a well-defined physical event has been found. For $Mn(NH_4)_2(SO_4)_2 \cdot 6H_2O$, $T_\lambda = 0.1763°K$, the width of the transition is known to $\pm2\ \mu°K$, and data have been obtained to $T-T_\lambda = \pm10^{-4}\ T_\lambda$. The precision in the differences, $T-T_\lambda$, is a few microdegrees near T_λ. A structured peak 5 m°K in width has been found in the heat capacity of $K_3Fe(CN)_6$ at about 0.130°K. For $CuK_2(SO_4)_2 \cdot 6H_2O$, $T_\lambda = 0.0295°K$, the width of the transition is known to ±0.2 m°K, and data have been obtained to $T-T_\lambda = \pm3\times10^{-2}\ T_\lambda$. The magnetic entropy has been found for the latter two salts. The results of these measurements are compared with the work of others on magnetic phase transitions and liquid-vapor phase transitions. Dissert. Abstr.

N68-20220# Bureau of Mines, Salt Lake City, Utah.
NONPYRITIC SMELTING OF COPPER CONCENTRATES
J. L. Reuss and M. M. Fine (Bur. of Mines, Minneapolis, Minn.) Apr. 1968 15 p refs
(BM-RI-7119)

The technical feasibility of smelting copper concentrates containing chalcocite (Cu_2S) and native copper using nonpyritic sulfur-bearing materials to aid matte formation was investigated. The procedure consisted of combining various proportions of commercial chalcocite concentrate, smelter slag, fluxes, and matte-forming constituents to produce charges of comparable

compositions. The mixtures were charged in fire-clay crucibles and smelted in an induction furnace at 1,300°C. The research proved that either sulfur or gypsum can replace pyrite as a matte-forming material, and that gypsum produces an exceptionally high-grade copper matte. The addition of small quantities of metallic iron to the nonpyritic smelting charge furthers the removal of sulfur, improves the recovery of copper, and makes it possible to utilize gypsum as the exclusive flux and matte-forming ingredient, thereby eliminating the necessity of adding limestone. Author

N68-20221# Bureau of Mines, Rolla, Mo.
TUNGSTEN WHISKERS BY VAPOR-PHASE GROWTH
A. G. Starliper and H. Kenworthy Apr. 1968 17 p refs
(BM-RI-7118)

Laboratory studies were made to produce whiskers of tungsten over a wide range of operating temperatures. Hydrogen reduction of tungsten hexachloride in a vacuum furnace at temperatures from 2,700° to 3,300°C yielded a small quantity of tungsten whiskers, provided a low degree of supersaturation was maintained. Direct measurements of 3,00,000 to 4,000,000 psi were obtained for the ultimate tensile strengths of individual whiskers averaging 3 to 4 microns in diameter with average aspect ratios of 1,000. This compares with strengths of 300,000 to 400,000 psi for 13-micron-diameter commercial filaments. Author

N68-20222 Florida State Univ., Tallahassee.
ANODIC OXIDATION OF PRIMARY ALIPHATIC AMINES
Karen Kinkel Barnes (Ph.D. Thesis) 1966 93 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-5518

The controlled potential oxidation of n-butylamine, hexylamine, i-butylamine, benzylamine, ammonia, n-propylamine, cyclohexylamine, allylamine, methylamine and t-butylamine at a platinum electrode in acetonitrile was studied. On the basis of the product analysis, the current-time curves obtained, which often peak instead of dropping exponentially, and the cyclic voltammetry curves which exhibit small slopes and do not vary with change in amine structure, a mechanism is proposed. Dissert. Abstr.

N68-20237 Catholic Univ. of America, Washington, D. C.
THE GAS PHASE THERMAL DECOMPOSITION OF METHYL AZIDE
Mylous Sexter O'Dell, Jr. (Ph.D. Thesis) 1966 81 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-7501

The investigation of the photolysis of methyl azide at low conversions showed that nitrogen was the major product. The results from "dark reactions" from that study further suggested that it was likely that the result would be the same in the thermal process at low conversions. This study reinvestigated the thermal decomposition, at low conversions, in an effort to observe the processes occurring in the initial stages of the reaction. The effects of time, temperature, concentration, surface-to-volume ratio, and the presence of foreign gases were also determined. It was concluded from the results that the gas phase decomposition of methyl azide was homogeneous and unimolecular over the pressure and temperature ranges studied. It was also inferred that free radicals very likely did not participate in the rate of nitrogen production. The results from the experiments with ethylene–azide mixtures suggest a possible bimolecular reaction between the azide and the olefin leading to the increased rate of nitrogen production. Dissert. Abstr.

N68-20240# McMaster Univ., Hamilton (Ontario). Dept. of Metallurgy and Materials Science.
ON THE SLOPE OF ETCH PITS
Michael B. Ives and Donald D. McAusland Jan. 1968 105 p refs
(Contract Nonr-3925(00))
(TR-11; AD-665280)

It is pointed out, by means of a literature review, that etch pits formed at the sites of singular defects in an otherwise slowly dissolving surface are usually shallow, composed of faces misoriented from that surface by only a few degrees. An etch pit study of the (0001) zinc surface dissolved in alcoholic hydrochloric acid solutions supports the theory that the slopes of etch pits are controlled by the dissolution kinetics of the crystals. Pits widen at a rate independent of the type of defect attacked, but the slopes are dictated by the relative rates of dissolution at the defect sites. Author (TAB)

N68-20243# Massachusetts Univ., Amherst. Polymer Research Inst.
POLARIZED INFRARED STUDIES OF AMORPHOUS ORIENTATION IN POLYETHYLENE AND SOME ETHYLENE COPOLYMERS
B. E. Read and R. S. Stein Sep. 1967 53 p refs Supported in part by NSF and Am. Chem. Soc.
(Contract Nonr-3357(01))
(ONR-TR-93; AD-664962)

Measurements were made of the dichroic ratios of a number of infrared bands for uniaxially deformed low-density polyethylene. In order to characterize the amorphous orientation in the polymer, orientation functions were derived from the results on the conformationally sensitive amorphous bands at 1368/cm, 1352/cm, 1303/cm and 1078/cm. In conjunction with x-ray data and infrared dichroism data on the crystalline 1894/cm band, amorphous orientation functions were also derived from the 2016/cm band which appears to contain a normal amorphous component. The results indicate that extended trans sequences in the amorphous phase orient to a larger extent than isolated trans bonds flanked by gauche bonds. Results on the bands at 720 and 730/cm appear to show discrepancies when compared with the data from the other bands, and possible reasons for this apparent inconsistency are suggested. Amorphous orientation functions have also been derived from the CN stretching band at 2250/cm in a copolymer of ethylene and (2 weight percent) acrylonitrile. The bands at 2016/cm and 1894/cm were also analyzed for this copolymer, in addition to a C = O stretching band at 1740/cm due, apparently to thermal oxidation. Infrared dichroism results are also discussed for a copolymer of ethylene and (4.1 mole percent) methacrylic acid in which 70% of the -COOH groups are neutralized with sodium hydroxide. Author (TAB)

N68-20247# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Raketentreibstoffe.
RESEARCHES ABOUT THE SYSTEM HYDRAZINE METHYLALCOHOL [UNTERSUCHUNGEN AM SYSTEM HYDRAZINMETHYLALKOHOL]
F. Bachmaier Jan. 1968 21 p refs In GERMAN; ENGLISH summary
(DLR-FB-68-05; DVL-704) CFSTI: HC $3.00/MF $0.65

This report gives information on the important physical and chemical properties of hydrazine–methylalcohol-mixtures. It informs about the experimental methods, which were used to determine the melting points, the heats of mixture, the decreases in volume, the densities, the viscosities, the thermal conductivities and the vapor pressures. The received results of the experimental investigations and theoretical performance calculations for combustion of a hydrazine–methylalcohol-fuel with fluorine as oxidizer show that this mixture can be used as a rocket fuel. Author

N68-20248 Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
RAPID SEPARATION OF RADIOACTIVE ELEMENTS BY EVAPORATION IN VACUUM [SZYBKIE ROZDZIELANIE PIERWIASTKOW PROMIENIOTWORCZYCH METODA ODPARONYWANIA W PROZNI]
Marian Gasior, Henryk I. Lizuraj, Henryk Niewodniczanski, I. Antoni, and W. Potempa 1967 20 p refs In POLISH; ENGLISH summary
(INP-584/PL) CFSTI: $3.00

An apparatus and techniques are described for the rapid separation of radioactive elements from the target material irradiated in a cyclotron. In order to choose the most suitable conditions for separation, a graph of the temperature dependence of the saturated vapor pressure of many elements is given. Some examples of the application of this method are also given. Author

N68-20251# Naval Research Lab., Washington, D. C.
THERMAL STABILITY OF ETHYLENE DINITRILOTETRA-ACETIC ACID AND ITS SALTS. PART 1: A LITERATURE SURVEY
D. L. Venezky 29 Dec. 1967 31 p refs
(NRL-6674; AD-664992)

From the standpoint of boiler-wall corrosion prevention, preliminary studies indicated that a chelating agent, ethylenedinitriloteraacetic acid (H4EDT), in conjunction with lithium hydroxide is preferable to the low-phosphate control treatment presently being used by the Navy. To elucidate the corrosion-inhibition mechanism in the lithium hydroxide-EDTA(4-) system, we must know the rate and the mechanism of EDTA(4-) decomposition in aqueous solutions under conditions of high-pressure boiler operations. As a background for investigations at this laboratory of the solid phase and solution phase decomposition of EDTA(4-) at high temperatures, the available literature has been examined and pertinent facts related to the lithium hydroxide-EDTA(4-) system are reported. The general properties of EDTA(4-) chelates are reviewed first. Although a considerable amount of information is available related to the use of alkali-metal hydroxides and EDTA(4-) solutions for hard-scale removal and corrosion prevention, no studies have been reported on decomposition products from aqueous EDTA(4-) solutions heated under pressure to high temperatures. The qualitative investigations of the thermal decomposition of solid H4EDTA and its metal salts fail to fully identify the volatile products and residues formed at temperatures near those of boiler operations. Author (TAB)

N68-20256 Iowa State Univ. of Science and Technology, Ames.
ANALYSIS OF CRYSTAL SIZE DISTRIBUTIONS WHEN GROWTH RATE IS SIZE DEPENDENT
Carl Frank Abegg (Ph.D. Thesis) 1966 101 p ref
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-5567

Empirical size dependent growth rate models are studied for their effect on the population density distribution from a continuous, mixed suspension, mixed product removal (CMSMPR) crystallizer. The growth rate models, and/or their corresponding population density distributions, are examined for continuity, versatility, convergence of moments, mathematical simplicity, and ability to fit experimental data. Based on this study, a new empirical size dependent growth rate model is proposed. Experimental steady state data are presented to illustrate the application of the model to actual CMSMPR crystallization systems. Dissert. Abstr.

N68-20259 Purdue Univ., Lafayette, Ind.
NUCLEAR MAGNETIC RESONANCE STUDIES OF HYDROGEN BONDING IN THE WATER–DIOXANE–CARBON TETRACHLORIDE TERNARY SYSTEM
Paul Simon (Ph.D. Thesis) 1966 87 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-5498

The chemical shift of very dilute solutions of water (less than 10^{-3} mole fraction) was measured over a wide range of concentrations of dioxane–carbon tetrachloride mixtures. Calculations based on the assumption that water self-association is negligible and that three species in rapid exchange are present fit the data very well. At all concentrations of donor solvent, the three solute species are: monomeric water, a 1:1 complex of water and dioxane, and 1:2 complex of one water molecule and two dioxane molecules. The average chemical shift was referred to the chemical shift of water in carbon tetrachloride at each temperature, which was shown to be characteristic of monomeric water. Dissert. Abstr.

N68-20310 Iowa State Univ. of Science and Technology, Ames.
HYDROXYAZO COMPOUNDS AS REAGENTS FOR BERYLLIUM
Laurie Murray Grennan (Ph.D. Thesis) 1966 130 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-5589

Attempts were made to improve the p-nitrobenzeneazoorcinol reagent by modifying its structure. A group of 26 monoazo compounds and two azo compounds were evaluated for their reaction toward beryllium. Synthesis and purification procedures were worked out for 1-(2'-carboxybenzeneazo)-2-hydroxy-5-methyl-benzene, o-carboxybenzeneazoorcinol, p-hydroxybenzeneazoorcinol, 1-(2'-hydroxy-4'-diethylamino-1'-benzeneazo)-3, 6-disulfo-8-hydroxy-naphthalene (Beryllon III) and 1-(1'-hydroxy-3'-sulfo-6'-iminodi-acetic-2'naphthylazo)benzene-2-arsonic acid (Beryllon IV). By means of a potentiometric titration procedure in 75 percent dioxane, values for the acid dissociation constants of the compounds studied; and the combining ratio and formation constants of the beryllium derivatives of each were measured. The data were treated mathematically using a modification of Bjerrum's method for metal-amine compounds. Absorption spectra of the compounds and the beryllium derivatives at optimum pH were obtained. Beryllon III and Beryllon IV are superior to the other three compounds. Dissert. Abstr.

N68-20327 Oklahoma Univ., Norman.
THE MECHANISM OF PARTIAL OXIDATION OF METHANE AT HIGH PRESSURES
Norman Lawson Hardwicke (Ph.D. Thesis) 1967 189 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-3975

The objective of this research was to obtain data on the thermal oxidation of methane at very high pressure, and with data available in the literature, propose a mechanism for the reaction. Pressures up to 100,000 psi. were investigated at various temperatures and reactor residence times. Oxygen content in the methane was maintained constant. The effects of alumina and silicon-containing compounds on the product distribution and reaction rate were investigated. Methanol, carbon dioxide, methyl formate, formaldehyde, formic acid and water concentrations in the product increased with increasing pressure, temperature and residence time. Carbon dioxide was formed at a temperature as low as 250°C, but carbon monoxide did not form below 285°C. Pyrex caused a more rapid reaction rate initially and after successive experiments, seemed to inhibit the reaction. It was concluded that carbon dioxide is made by a chain reaction through complexing of the dioxymethyl radical at the walls of the reactor with oxygen. When temperature is high enough (285°C) and after an induction time, the dioxymethyl radicals are able to decompose and enter a chain reaction in which carbon monoxide is formed. This work supported the proposal that methanol is made in a three step chain reaction in which methyl hydroperoxide is an intermediate product. Dissert. Abstr.

N68-20337# Adelaide Univ. (Australia). Dept. of Physics.
EXPERIMENTAL OSCILLATOR STRENGTHS FOR THE SCHUMANN–RUNGE BAND SYSTEM IN OXYGEN
A. J. D. Farmer, W. Fabian, B. R. Lewis, K. H. Lokan, and G. N. Haddad Feb. 1968 22 p refs
(Grant AF-AFOSR-1131-66)
(ADP-44)

Oscillator strengths for the (2,0)–(20,0) bands of the $B^3\Sigma_u^- - X^3\Sigma_g^-$ Schumann–Runge system in molecular oxygen have been determined from absolute measurements of the absorption coefficient over the wavelength range 1700–2000Å. The measurements were made with an instrument resolution of 0.3Å, under conditions of very small attenuation, so that the observed absorption was directly proportional to the absorption coefficient, regardless of the absorption profile. The oscillator strengths vary over three orders of magnitude, and reach a maximum at the (14,0) vibrational transition. The magnitude and distribution of oscillator strength throughout the vibrational bands agree closely with the estimates derived from a semiempirical potential. Author

N68-20424# Air Force Office of Scientific Research, Washington, D. C.
DIRECTORATE OF CHEMICAL SCIENCES PROGRAM REVIEW
William L. Ruigh and Edward T. Walford Dec. 1967 211 p refs
(AFOSR-67-2237; AD-665133)

The review provides a unified record of research in progress together with achievements resulting from the basic research program of the Directorate of Chemical Sciences, AFOSR (OAR). There are three main sections in the review. The first section is devoted to research high-lights under the headings of Aerospace Chemistry, Chemical Reactivity and Mechanisms, Boron, Glass, Electrochemistry, Inorganic Chemistry, and the Characterization of Liquids. The middle section contains geographic and other Program statistics, a list of scientific reports received during the year, and a list of active projects. In the final section a factual summary is provided for each project which was completed during fiscal year 1967. Author (TAB)

N68-20452# Naval Radiological Defense Lab., San Francisco, Calif.
RADIOACTIVITY GROWTH-DECAY DATA: ANALYSIS BY APPLICATION OF THE LEAST-SQUARES METHOD
Sachio Yamamoto and Mark Brown Oct. 1967 46 p refs
(USNRDL-TR-68-5; AD-665666)

The method of least sqaures has been applied to the analysis of growth-decay counting data and time-dependent gamma-ray pulse-height spectral data obtained from mixtures of genetically related nuclides. From the counting data, estimates can be obtained of the parent activity at the time of start of product growth and of the relative detection efficiencies (i.e., the total detection efficiency of one nuclide relative to that of another). From the gamma-ray spectral data, estimates can be obtained of the spectrum of each nuclide in the decay chain. TAB

N68-20475# General Dynamics Corp., San Diego, Calif. General Atomic Div.
NEUTRON AND GAMMA RAY PRODUCTION CROSS SECTIONS FOR SODIUM, MAGNESIUM, CHLORINE, POTASSIUM, AND CALCIUM. PART 4: CHLORINE
M. S. Allen and M. K. Drake Nov. 1967 139 p refs
(Contract DA-18-035-AMC-730(A))
(GA-7829; NDL-TR-89-4; AD-665362)

An investigation was made of the neutron interaction probabilities with the element chlorine. Sets of recommended total and partial neutron cross sections were prepared. The energy and angular distributions of the secondary neutrons are given. Also, gamma ray production cross sections were obtained as well as energy and angular distributions of the secondary gamma rays. In general, the recommended data were based on experimentally measured data. However, where no experimental data were available, the recommended cross sections were obtained using model calculations. Author (TAB)

N68-20494# Rocket Propulsion Establishment, Westcott (England).
THE IONIZATION POTENTIAL AND HEAT OF FORMATION OF THE $(CH_3)_2N$ RADICAL BY MASS SPECTROMETRY
I. P. Fisher and E. Henderson London Min. of Technol. Mar. 1967 17 p refs
(RPE-TR-67/4) CFSTI: HC $3.00/MF $0.65

The ionization potential of the $(CH_3)_2N$ radical, obtained by pyrolysis of 1,1 dimethylhydrazine and of dimethylnitrosamine, has been determined directly as 9.42±0.1 eV. $\Delta H_f((CH_3)_2N)$ has been calculated to be 30.3±2 kcal $mole^{-1}$. This figure agrees with the kinetic value thus resolving this discrepancy between the latter and previous electron impact values. Electron affinities were obtained as follows: $EA(NH_2)$ = 1.05±0.1 eV and EA(NO) = 0.8±0.1 eV. Author (ESRO)

N68-20496 California Univ., Davis.
STEREOCHEMISTRY OF ASYMMETRIC SILICON: FORMATION AND CLEAVAGE REACTIONS OF THE SILICON–CARBON BOND
William David Korte (Ph.D. Thesis) 1966 132 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-5244

Simple organolithium reagents, such as alkyl-, aryl-, and ethynyl-lithium reagents, displaced "poor leaving groups," such as the fluoride, methoxide, and hydride ions, from asymmetric silicon by a retention stereochemistry and displaced "good leaving groups," such as the chloride ion, by an inversion stereochemistry. Charge delocalized organolithium reagents which have more ionic character in the carbon–lithium bond than simple organolithium reagents followed a more complex pattern of reaction. With such reagents, the fluoride and methoxide ions as well as the chloride ion were displaced from asymmetric silicon by an inversion stereochemistry, but the hydride ion was displaced by a retention stereochemistry. There were several anomalies in this pattern, such as the coupling of α-picolyllithium with the fluorosilane and the methoxysilane by retention of configuration and the coupling of benzhydryllithium with the silane by inversion of configuration. Dissert. Abstr.

N68-20513 Indian Inst. of Tech., Kanpur.
ASYMMETRY PARAMETERS FROM THE CHLORINE NUCLEAR QUADRUPOLE RESONANCE SPECTRA OF SOME ORGANIC COMPOUNDS
P. T. Narasimhan *In its* Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 244–246 refs (See N68-20501 10-26)

Frozen samples at liquid nitrogen temperature were used to determine asymmetry parameter values of the following compounds: CH_2Cl_2, $CHCl_3$, $CDCl_3$, $H_3C{-}CCl_3$, and C_6H_5Cl. The resonating nucleus is Cl^{35}. In determining the asymmetry parameter, the nuclear quadrupole resonance signal without magnetic field is recorded and then a uniform magnetic field is applied parallel to the radio frequency field. The Zeeman spectra obtained are analyzed to determine the parameter values. It is also reported that a colloid band, quite distinct from the X band, was observed in KI single crystals. The band is believed to be produced by slow cooling after electrolytic coloration at 550°C. M.G.J.

N68-20514 Indian Inst. of Tech., Kanpur.
SEMICONDUCTION IN RARE EARTH OXIDES
G. V. Chandrashekharan, P. N. Mehrotra, G. V. Subba Rao, E. C. Subba Rao, and C. N. R. Rao *In its* Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 250–251 (See N68-20501 10-26)

Electrical conductivity measurements of several rare earth sesquioxides over a wide range of temperatures show a break in the conductivity curve around 550°C, indicating a change in the conduction mechanism. Summary data are also presented on (1) whisker formation in single crystals of silver chloride during growth process, (2) etching solutions for revealing dislocations in KCl crystals, (3) spectroscopic studies of irradiated alkali halide crystals, (4) diffusion of boron and phosphorus in silicon, (5) Bridgman–Stockbarger technique for growing single crystals of naphthalene, and (6) electron tunneling in thin Nb_2O_5 films. M.G.J.

N68-20522 California Univ., Riverside.
STUDIES IN CARBORANE CHEMISTRY
Donald Clifford Young (Ph.D. Thesis) 1966 139 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-5867

The icosahedral *carborane* 1,2-dicarbaclovododecaborane-(12), $B_{10}C_2H_{12}$, and its carbon-substituted derivatives can be degraded by alcoholic potassium hydroxide to the (3)-1,2-dicarbadodecahydroundecaborate(-1) ion, $B_9C_2H_{12}^-$. The proposed structure of the $B_9C_2H_{12}^-$ ion is an icosahedral fragment 2.35 and 2.40. Aluminum concentration was varied over a tenfold range. Each solution contained a one molar sodium perchlorate supporting electrolyte. The densities, turbidities, and refractive index increments of each solution were determined, and weight average degrees of polymerization were calculated. The results indicate the degree of polymerization is a continuous function of the hydroxyl number varying from two aluminum atoms per aggregate at hydroxyl number 1.00 to seven aluminum atoms per aggregate at the higher hydroxyl numbers. Appreciable perchlorate complexing is indicated. The degree of aggregation is also found to be partially dependent upon the time allowed for and the temperature of the hydrolysis reaction. Dissert. Abstr.

N68-20523 California Univ., Davis.
ELECTRON SPIN RESONANCE INVESTIGATION OF NITROGEN CONTAINING FREE RADICALS
Steven George Hadley (Ph.D. Thesis) 1966 73 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-5240

The electron spin resonance spectra of some free radicals containing nitrogen have been observed. The magnitude of the nitrogen hyperfine interaction has been measured and related to current theoretical and experimental data. The ESR spectra of methylamino and dimethylamino free radicals were observed in the solid phase at 77°K. Methylamino free radical was generated by photolysing methylamine; dimethylamino free radicals were generated by photolysing dimethylamine and trimethylamine. The courses of these reactions were determined by studying the ESR spectra of the free radicals derived from various deuterated molecules. Radicals from the reaction of hydroxyl with n-propanolamine and ethanolamine in a flow system at room temperature have been studied. Dissert. Abstr.

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N68-19592 Michigan State Univ., East Lansing.
TRAVELING WAVE ANTENNAS WITH IMPEDANCE LOADING
Dennis P. Nyquist (Ph.D. Thesis) 1966 220 p
Available from Univ. Microfilms: HC $9.90/MF $3.00 Order No. 67-7587

The circuit and radiation characteristics associated with thin-wire traveling wave antennas are desirable for certain applications. In this thesis, specific consideration is given to two members of the class of thin-wire antennas: (1) the linear antenna and (2) the circular loop antenna. An impedance loading technique is utilized in either case to modify the usual standing wave distribution of antenna current. It is indicated that a traveling wave of current may be excited on such thin-wire antennas through the use of an optimum impedance loading. Perhaps the most significant result of this research is the conclusion that a traveling wave antenna may be realized through the use of a purely non-dissipative loading. Explicit expressions for the reactance and position of such an optimum loading are presented. Approximate expressions for the input impedance and radiation fields of the traveling wave antenna are given in terms of its dimensions and the frequency of excitation. Numerical examples are presented for antennas of specific dimensions to illustrate these theoretical results. Dissert. Abstr.

N68-19609 Syracuse Univ., N. Y.
ANALYSIS OF A PROBE RING ANTENNA
Stephen Nicholas Andre (Ph.D. Thesis) 1966 111 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-7056

The antenna investigated is comprised of a ring of uniformly spaced coaxially fed probes coupled to a uniform radial transmission line. Using the results of this investigation it is possible to determine the probe impedances and radiation pattern for any set of excitation voltages. The rotational symmetry of the probe ring is used to determine the eigenvectors of the probe impedance matrix and the form of the wave function in the radial transmission line. The eigenvalues of the impedance matrix are then determined by solving the boundary value problem of a coaxially fed probe coupled to the wave function in the radial transmission line. The probe diameter is assumed small with respect to wavelength to simplify the analysis. The analysis of the probe ring antenna for any set of excitation voltages is performed using an eigenvector expansion and the even and odd probe ring impedances determined by the boundary value solution. Approximate expressions are given for the far field patterns of the probe ring with eigenvector excitation. Dissert. Abstr.

N68-19617 Syracuse Univ., N. Y.
MUTUAL INFORMATION IN NARROW BAND RANDOM PHASE CHANNELS
Joseph George Kneuer (Ph.D. Thesis) 1966 162 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-7079

The problem of time scale uncertainty or loss of synchronization in a communications system is introduced in terms of mutual information. Information capacity as an upper bound on channel performance is considered in relation to the evaluation of attainable lower bounds. The memoryless, narrow band, random phase channel is described in terms of both constant known gain (Rician statistics) and Rayleigh fading models. In terms of the channel models, mutual information is contained entirely in the amplitude. A discrete scheme is derived for representing the continuous channel models with arbitrarily small loss in mutual information. In combination with an optimization procedure this can provide a strict numerical bound for channel capacity. The basic scheme for optimization is applied in a restricted manner to methodically improve mutual information in the channels, as a function of the

transmitter amplitude distribution. In a check calculation on the gaussian additive noise channel, the program is seen to yield results closely approximating the known bound. Dissert. Abstr.

N68-19624*# National Aeronautics and Space Administration, Washington, D. C.
CONSTRUCTING INEXPENSIVE AUTOMATIC PICTURE-TRANSMISSION GROUND STATIONS
Charles H. Vermillion 1968 68 p refs
(NASA-SP-5079) CFSTI: HC $3.00/MF $0.65 CSCL 17B

This report describes how one can procure or build the antenna, FM receiver, and other components for an Automatic Picture Transmission (APT) ground station. Detailed drawings and parts lists are included. Installation, alignment, and operation of the APT ground station are also described. APT ground stations are inexpensive and reliable. They can be built from surplus parts for under $500 or procured for as low as $5000. With them, scientists, local weather stations, amateurs, and others can receive satellite-taken photographs of the Earth as APT-equipped satellites pass overhead. It is currently planned that APT systems compatible with the ground station will be flown on Nimbus and ESSA satellites at least until 1972. It is probable that similar or advanced APT systems will be available after 1972, although these programs are still in a tentative planning stage. Author

N68-19632*# ADCOM, Inc., Cambridge, Mass.
SPECIAL STUDIES OF AROD SYSTEM CONCEPTS AND DESIGNS
D. Bradley Crow, Ahmad F. Ghais, and S. Ahmed Meer 31 Jul. 1967 72 p refs
(Contract NAS8-20128)
(NASA-CR-61670; G-69; TR-4) CFSTI: HC $3.00/MF $0.65 CSCL 17I

Signal processing techniques for the Airborne Range and Orbit Determination (AROD) system are discussed with respect to existing sources of error, and other vehicle and ground station instrumentation functions. Correlation properties of the AROD ranging code are derived for use in evaluating signal acquisition procedures used in the vehicle tracking receiver. Range errors incurred by atmospheric propagation are examined in terms of both ionospheric and tropospheric error sources. Simple and approximate bounds are derived for these errors, and the possibility and merits of gross range corrections are discussed. The AROD vehicle-borne computer functions are described along with the mathematics for translating ground station coordinates to the vehicle-borne computer coordinate system. E.J.S.

N68-19674# Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.
RADIO PROPAGATION IN RE-ENTRY PLASMAS
James E. Drummond Oct. 1967 16 p refs
(D1-82-0698)

Altitude versus speed profiles for space ships entering earth's atmosphere from orbit, from the moon, and from a planet were used to estimate plasma and collision frequencies in the stagnation and expansion regions. The lunar and planetary profiles are shown to result in plasmas dominated by non-local conductivity. Weibel's analysis is adapted to apply for "whistler" mode propagation in a plasma with a magnetic field. The B field produced by a ferrite radio window (250 gauss 10 cm from its pole face) is used to calculate the attenuation parameter of a 100 MHz telemetry signal. It is found that the radio "blackout" along the orbital re-entry profile is eliminated for these parameters. However, this is not so for the lunar and planetary re-entry profiles. It would require about twenty-five times as much B field to cure these "blackout" blues. Author

N68-19683 Washington Univ., Seattle.
PROLATE SPHEROIDAL WAVE FUNCTIONS AND THEIR APPLICATION TO PLANAR APERTURE ANTENNA PATTERN SYNTHESIS
William Paul Harthill (Ph.D. Thesis) 1966 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-7644

This dissertation treats the problem of analytically continuing, throughout the complex plane, an arbitrary bandlimited function which is initially specified only on some finite real interval. A practical analytic continuation technique is developed which is based upon the dual orthogonality property of the prolate spheroidal wavefunction. The practical aspects include the elimination of the integrations normally associated with the Fourier series of prolate spheroidal wavefunctions. The analytic continuation technique utilizes a set of Γ coefficients to continue an arbitrary function specified in its interval of definition by a trigonometric Fourier series. The technique results in a trigonometric Fourier series for the frequency spectrum and, if desired, a sampling function representation of the continuation. The continuation technique is applied to the planar aperture antenna pattern synthesis problem and simplified expressions for the supergain ratio are developed. Dissert. Abstr.

N68-19741 California Univ., Berkeley.
ON THE DESIGN OF RANDOM SIGNALS
Adnan Ahmed Al-Shalchi (Ph.D. Thesis) 1966 161 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-4989

In this thesis, we have studied the design of random signals for digital communication. We have dealt with situations where one has at the receiver a zero-mean, Gaussian process with a covariance function K_{s1} (t,s) or K_{s2} (t,s). This process is corrupted by an independent, additive zero-mean, noise process. The problem is to select the shapes of the signal covariance functions, subject to power and bandwidth constraints, so as to minimize the probability of making an error in deciding which of the two signal processes was present, on the basis of an observation of finite duration T. Using a theorem of Root for simultaneously diagonalizing two separable, zero-mean, Gaussian processes whose corresponding Gaussian measures are equivalent, we obtain representations for the signal and noise processes in terms of certain series of time functions. This representation is general for on-off keying (OOK). For binary two-level keying, it is not the most general; however it is of sufficient generality to include interesting situations such as binary symmetric keying (BSK). We have restricted ourselves to a received signal space of finite dimension. Dissert. Abstr.

N68-19771# Naval Air Systems Command, Washington, D. C.
RADIO SET TRANSFER CONTROL TEST SET TS-1749/SRM-2
15 Apr. 1967 8 p
(NAVAIR-17-20BCK-1; PB-177012) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of Radio Set Transfer Control Test Set TS-1749/SRM-2 manufactured by Babcock Electronics Corporation. Author

N68-19776# Miami Univ., Fla. Radar Meteorological Lab.
SFERICS-TO-RADAR DATA CONVERTER
George F. Andrews Nov. 1967 26 p
(Contract Nonr-4008(12))
(ML-68023; TR-1; AD-665009)

The report briefly describes the techniques employed in the design and development of a data converter to permit simultaneous cathode-ray tube display of sferics activity and radar weather echoes. Author (TAB)

N68-19789*# Sylvania Electric Products, Inc., Waltham, Mass. Electronic Systems Eastern Div.

ADVANCED TECHNOLOGICAL SATELLITE ELECTRO-MECHANICAL DESPUN ANTENNA Final Report

L. Blaisdell 19 Oct. 1967 151 p refs

(Contract NAS5-9521)

(NASA-CR-93732; F181-1) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Following the development of two breadboard models and a prototype, two flight models of a microwave frequency electromechanical despun antenna system were designed to operate in space for a one-year minimum with a five-year design goal. The antenna system, consisting of a mechanical drive assembly and four separate control electronic packages, is mechanically and electrically compatible with a cylindrical spin-stabilized spacecraft for satellite communications with earth stations. Overall performance of the antenna system is reported and specifications and requirements are defined for the radio frequency, control electronics, and environmental and mechanical areas. Thermal interface between the mechanically despun antenna and the spacecraft was analyzed, and the antenna system met all design specifications and performance requirements. A motor drive, bearing, and lubrication system performed successfully for 7800 hours in a vacuum of 10^{-7} Torr. Temperature was found to be the most sensitive environment of the control electronics system, and the flight systems were successfully tested to temperature limits equal to the qualification test limits. M.W.R.

N68-19825*# ADCOM, Inc., Cambridge, Mass.

SPECIAL STUDIES OF AROD SYSTEM CONCEPTS AND DESIGNS

E. J. Baghdady, K. W. Kruse, and S. A. Meer 15 Jan. 1967 68 p refs

(Contract NAS8-20128)

(NASA-CR-61667; G-69-TR-1; TR-1) CFSTI: HC $3.00/MF $0.65 CSCL 17I

Signal-to-noise ratios in the airborne ranging and orbit determination (AROD) system are computed for the vehicle tracking receiver (VTR), and the station control receiver (SCR) and its data demodulator. The computations show that the system has sufficient signal-to-noise ratio margin at the maximum range of 2000 km. A carrier loop model is derived in the form of the conventional phase-locked loop (PLL), and it is shown that the carrier loop can be reduced to a standard second-order PLL with different dc and ac gains. The design relations and performance of an RC-integrator type memory are discussed, and the phase error due to the effects of switching of the S-band transponder antenna on the VTR is obtained. Range loop performance analyses were conducted to assess the effect of uplink data on L-code acquisition, and to examine the combined carrier and range processing scheme used in AROD. Also presented is a noise analysis of the coherent AGC for the VTR carrier loop IF amplifier, which considers both the phase error due to noise in the carrier loop and the nonlinear transformation of the Gaussian IF noise by the AGC amplifier. M.G.J.

N68-19826*# ADCOM, Inc., Cambridge, Mass.

SPECIAL STUDIES OF AROD SYSTEM CONCEPTS AND DESIGNS

D. Bradley Crow 15 Oct. 1966 76 p refs

(Contract NAS8-20128)

(NASA-CR-61668; G-69-TR-2; TR-2) CFSTI: HC $3.00/MF $0.65 CSCL 09F

To aid in the design of the airborne ranging and orbit determination (AROD) ground station antenna and direction-finding (D/F) system, signaling and signal processing techniques were investigated. The D/F system accuracy, as related to gain and phase irregularities in one of the system preamplifiers, is analyzed, and estimated signal and noise levels in the system are computed. Consideration is also given to the phase meter threshold, which is defined as that input signal-to-noise ratio at which the phase meter output becomes unreliable due to noise. Subsystem component tests are described, and graphs interpreting the results are presented. The Doppler frequency shift on local oscillator signals of the station control receiver is analyzed, and methods of accomplishing phase meter output filtering are described. Various D/F receiver techniques are assessed, and two fundamental receiver designs are presented. Both utilize local oscillator signals from the station control receiver for removal of Doppler. Techniques for achieving the required narrow noise bandwidth are discussed, and various conventional filters are surveyed. M.G.J.

N68-19829*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPLORING IN AEROSPACE ROCKETRY. 13: TRACKING

John L. Pollack Washington 1968 19 p refs Presented at the Lewis Aerospace Explorers Conf., Cleveland, 1966–1967

(NASA-TM-X-52400) CFSTI: HC $3.00/MF $0.65 CSCL 17I

Consideration is given the tracking techniques to establish the position-time history of a vehicle for observation, guidance, or navigation. Radar, radio, and optical tracking systems are analyzed, and the advantages and the purposes of each are cited. Details are given on the 10-percent rule and its application to the tracking of model rockets of which the main goal is to obtain the maximum altitude of the rocket. The effects of elevation and azimuth angles on the accuracy of tracking stations is also examined. B.S.D.

N68-19843# Harvard Univ., Cambridge, Mass. Cruft Lab.

RESEARCH IN ELECTROMAGNETIC RADIATION AND ANTENNAS: A SUMMARIZING REVIEW Final Report, 1 Feb. 1963–31 Oct. 1967

Ronald W. P. King Dec. 1967 22 p refs

(Contract AF 19(628)-2406)

(AFCRL-67-0667; AD-665144)

Research in electromagnetic radiation and antennas under Contract AF19(628)-2406 is summarized for the period from February 1, 1963 to October 31, 1967. Brief reviews are given of work on antenna arrays, antennas in a parallel plate region with ferrite and plasma layers, the electrically thick antenna, the helical antenna, the dielectric-coated antenna, and the inverse scattering problem for an inhomogeneous cylinder. Author (TAB)

N68-19872# RAND Corp., Santa Monica, Calif.

CONCEPTUAL APPROACHES IN THE DESIGN OF OPTIMAL RADAR AND SONAR SYSTEMS: CANONICAL METHODS, MODELS, AND OPERATORS

D. Middleton Feb. 1968 55 p refs

(Contract F44620-67-C-0045; Proj. RAND)

(RM-5475-PR; AD-665111)

Part of a study undertaken to develop formal methods for investigating the design of optimal radar (and sonar) systems as a totality and in terms of functional elements, in a way that treats the physical model, the system purpose, and the criteria involved in a unified fashion. This Memorandum specifically examines the context in which various canonical methods (based on the philosophy of statistical communication theory) can be used (1) to provide optimal system design or system structure, (2) to evaluate the expected performance of such systems, and (3) to compare the performance of these theoretical ideal systems with that of their real approximations. Author (TAB)

N68-19904# Army Engineer Waterways Experiment Station, Vicksburg, Miss.

EFFECT OF ANTENNA OPERATION ON STRUCTURE AND FOUNDATION BEHAVIOR, AMRAD AND RAMPART RADAR TOWERS, WHITE SANDS MISSILE RANGE, NEW MEXICO Final Report

Robert F. Ballard, Jr. and Jack Fowler Dec. 1967 52 p refs
Its Misc. Paper No. 4-955
(AD-664764)

The effects of antenna operation on the structure and foundation behavior of AMRAD and RAMPART radar towers were studied. The towers were almost identical except for small differences in foundation diameter and structure height. Displacements, frequencies, phase of movement, and attenuation characteristics of the towers were determined. Transducers were positioned to measure movement in three planes: one vertical, and two horizontal (mutually perpendicular to each other and in the plane of rotation). The greatest displacements occurred near the tops of the structures during the azimuth (torsional) and elevating (rocking) modes of antenna operation, and decreased in magnitude toward the foundation. The average maximum displacements at each instrumented location were plotted from data collected for the azimuth and elevating modes of antenna operation. The AMRAD antenna was operated at twice the velocity of the RAMPART antenna, and AMRAD displacements recorded during the rocking mode were approximately twice those of RAMPART. TAB

N68-19934*# Sylvania Electric Products, Inc., Waltham, Mass. Electronic Systems Eastern Div.
ADVANCED TECHNOLOGICAL SATELLITE ELECTRO-MECHANICAL DESPUN ANTENNA. APPENDICES Final Report
L. Blaisdell 19 Oct. 1967 278 p
(Contract NAS5-9521)
(NASA-CR-93735; F181-1, App.) CFSTI: HC $3.00/MF $0.65
CSCL 09F

Results obtained during the development of an electromechanical despun antenna for advanced technological satellites are presented. Graphs and tables detail the radio frequency pattern and impedance test data results, vibration test reports, and control electronics data and system power drain. Procedures and results are given for flight model number one of the despun antenna for radiated interference in the 15kHz to 1 GHz range and for power line interference from 150 kHz to 25 MHz. Thermal energy exchange was determined between the mechanically despun antenna and the satellite for three synchronous orbits; a 58-zone mathematical model was used to describe the thermal behavior of the antenna and the equations were solved by computer. M.W.R.

N68-19976# Naval Research Lab., Washington, D. C.
RADIO RAY (RADAR) RANGE-HEIGHT-ANGLE CHARTS Interim Report
Lamont V. Blake 22 Jan. 1968 22 p refs
(NRL-6650; AD-665018)

Charts showing the relationship of range, height, and initial elevation angle of the rays from an earth-based antenna have been machine-computed and machine-drawn. The refracted (curved) ray paths are represented on the charts as straight lines, which facilitates plotting radio and radar vertical-plane coverage diagrams. The negative-exponential model of tropospheric refractivity has been assumed, although the method permits any model representable by a piecewise-continuous function to be used. Charts have been made for various systems of range, height, and angle units with equal and unequal range and height scales, with both linear and nonlinear scales, and for both small and large maximum range and height. Author (TAB)

N68-19981# Lincoln Lab., Mass. Inst. of Tech., Lexington.
DECISION-FEEDBACK EQUALIZATION FOR DIGITAL COMMUNICATION OVER DISPERSIVE CHANNELS
Michael E. Austin (Ph.D. Thesis) 11 Aug. 1967 90 p refs
(Contract AF 19(628)-5167; ARPA Order 498; Proj. Defender)
(ESD-TR-67-466; TR-437; TR-461; AD-664926)

A decision-theory approach to the problem of digital communication over known dispersive channels is adopted to arrive at the structures of the optimal and two sub-optimal receivers: the conventional and decision-feedback equalizers, both employing matched and transversal filters. The conventional equalizer is similar to some equalization modems finding current application, while the new decision-feedback equalizer (as its name implies) utilizes its previous decisions in making a decision on the present baud. TAB

N68-19984# Naval Research Lab., Washington, D. C.
POWER SPECTRUM ESTIMATES OF SAMPLED PSEUDO-RANDOM SEQUENCES Interim Report
Caldwell McCoy, Jr. 29 Dec. 1967 92 p refs
(NRL-6673; AD-664649)

The report concerns power spectrum estimates of sampled pseudo-random signals, and shows that for these signals the spectral power is more relevant than, say, the autocorrelation function. The power spectrum estimates considered here assume stationarity and zero means. The signal under investigation is a pseudo-random noise signal obtained from maximal length sequences. Pseudo-random signals are popular because (a) they can be fashioned with relative ease from linear shift registers, (b) their deterministic waveforms have uniform power throughout their bandwidths, and (c) their autocorrelations are approximately zero outside a narrow peak at zero tau. This study is concerned with some applied methods and results of these applications to bandlimited signals that have been corrupted by additive-noise, multiple-path, and Doppler effects and that have been processed digitally to obtain correlations and power spectra. The object was to observe the effects on the power spectrum estimates due to these perturbations. The analysis was performed exclusively on filtered maximal length pseudo-random sequences. These filtered sequences were tailored to a bandwidth and sample size to yield optimal results for a given computer memory capability. Author (TAB)

N68-20038*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A MISSION, TRACKING, COMMUNICATION AND FLIGHT OPERATION STUDY FOR THE GALACTIC JUPITER PROBE
Sep. 1967 143 p refs
(NASA-TM-X-63149; X-500-67-228) CFSTI: HC $3.00/MF $0.65
CSCL 17I

Trajectory and guidance and navigation analyses are detailed for the galactic Jupiter probe; and details are presented for ground network support, the communication and data handling system, and spacecraft flight operations and scheduling. The trajectory analysis deals with injection requirements, launch period, and launch vehicle payload estimates for the earth escape phase; requirements for the cruise phase; approach asymptote and hyperbolic excess speed for the Jupiter approach phase; and encounter geometry and flybys for the post-encounter phases. Station description, selection, and coverage for the ground network is covered. Spin axis direction determination for the galactic Jupiter probe is described, and modulation/detection methods for optimal tracking are discussed. M.W.R.

N68-20043*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
IONOSPHERIC EFFECTS ON TELEMETRY AND TRACKING SIGNALS FROM ORBITING SPACECRAFT
R. J. Coates and T. S. Golden Mar. 1968 11 p refs
(NASA-TM-X-63152; X-520-68-76) CFSTI: HC $3.00/MF $0.65
CSCL 09F

Ionosphere characteristics important to space telemetry are discussed. Projections of auroral interference through 1969 are made based on correlation of measurements with solar activity data. Measured results of disturbances at equatorial tracking stations are presented. Author

N68-20047# Lockheed-California Co., Burbank.
HIGH FREQUENCY ANTENNA COUPLER Interim Engineering Report, 29 Jul.–15 Oct. 1967
Carlyle W. Smith 12 Jan. 1968 14 p
(Contract NOw(A)-66-0039-F)
(CWS-1; IER-1; AD-665012)

The High Frequency Antenna Coupler is designed to provide impedance matching between high frequency wire antenna or prove antenna and high frequency radio sets aboard the P-3C aircraft. A study was made to increase the tuning range requirements for the probe antenna, to reduce the long tune time at low frequency, and to improve the power handling capability at low frequency. A method of network selection logic was developed which is dependent on the actual antenna impedance and generated during the tuning sequence. The projected weight and the size for the unit is within the specification requirements. Author (TAB)

N68-20063# Sylvania Electric Products, Inc., Waltham, Mass. Applied Research Lab.
PROPAGATION OF ELF AND VLF WAVES BELOW A GENERALLY ANISOTROPIC IONOSPHERE
Janis Galejs Jan. 1968 18 p refs
(RR-548; AD-665007)

The mode analysis of ELF and VLF waves has been generalized to allow arbitrary directions of propagation below a curved stratified ionosphere with a dipping static magnetic field. In the ELF range, the propagation parameters are changed almost linearly with the azimuthal angle phi by varying the direction of propagation from East to West. In the VLF range, the phase velocity exhibits its maximum value for propagation in South and North direction; and minimum values occur for propagation towards West. Also, maximum attenuation rates occur for propagation towards West. Measured interference distances D of the two lowest wave-guide modes have been explained using nighttime ionosphere models which exhibit sharp density gradients in the height range from 80 to 85 km. Author (TAB)

N68-20070# Hawker Siddeley Dynamics, Ltd., Stevenage (England). Command and Tracking Group.
ELDO INITIAL PROGRAM. R.F.I. MEASUREMENTS CARRIED OUT ON THE EMU F6/2 BUILD AT STEVENAGE DURING MAY 1967
J. Kerr, comp. and D. Waller, comp. Paris ELDO 23 Jun. 1967 24 p Prepared for ELDO
(ELDO-RFI-10; LX-288) CFSTI: HC $3.00/MF $0.65

The results of the sesensitization tests on Wrebus receivers by the T37 sender (first stage) and the PCM/FM sender (third stage) are given. Also the results of multicoupling tests using the vehicle transmitting with working frequencies below 1000 Mc/s and the Wrebus receivers are recorded for a number of aerial configuration as well as the results of multicoupling tests using the two radar transponders (second stage). Author (ESRO)

N68-20071# Selenia S. P. A., Rome (Italy).
ELDO INITIAL PROGRAM. F-6/1 MULTISTAGE VEHICLE. RADIO FREQUENCY INTERFERENCE THEORETICAL STUDY: ASSEMBLED VEHICLE ON ITS OWN
Paris ELDO 23 Aug. 1967 145 p refs Prepared for ELDO
(ELDO-RFI-7; TR-67/525) CFSTI: HC $3.00/MF $0.65

All possible interference among various onboard r.f. equipment for the F-6/1 flight configuration are examined. The main r.f. characteristics of the ELDO vehicle are recalled and the operating and spurious frequencies of transmitters are analyzed. Path attenuations between possible interfering transmitters and receivers are investigated in order to ascertain preventive and corrective actions to be assumed to avoid receivers desensitization. A short mention is made of the Stevenage tests in order to point out objects of the trials. Author (ESRO)

N68-20102# Selenia S. P. A., Rome (Italy).
ELDO INITIAL PROGRAM. F-6/2 MULTISTAGE VEHICLE RADIO FREQUENCY INTERFERENCE THEORETICAL STUDY: ASSEMBLED VEHICLE ON ITS OWN
Paris ELDO 8 Sep. 1967 143 p refs Prepared for ELDO
(ELDO-RFI-11; TR-67/536) CFSTI: HC $3.00/MF $0.65

All possible interference among various on board r.f. equipment for the F-6/2 flight configuration are examined. The main r.f. characteristics of the ELDO vehicle are recalled and the operating and spurious frequencies of transmitters are analyzed. Path attenuations between possible interfering transmitters and receivers are investigated in order to ascertain preventive and corrective actions to be assumed to avoid receivers desensitization. A short mention is made of the Stevenage tests in order to point out objects of the trials. Author (ESRO)

N68-20106# Navy Electronics Lab., San Diego, Calif.
CURRENT DISTRIBUTIONS AND RADIATION PATTERNS FOR CIRCULAR-ARRAY RADAR ANTENNA: THEORY Research Report, Jul. 1966–Jun. 1967
A. D. Munger 26 Oct. 1967 50 p refs
(NELC-1521; AD-664826)

As part of an overall program to find the best circular and cylindrical configurations for use as fixed radar-scanning-antennas, this report covers the theory relating current distributions to radiation patterns. It includes computations based on the Tchebycheff synthesis for CARAMBA (Circular-Array Radar Agile Moving Beam Antenna). Author (TAB)

N68-20107*# ADCOM, Inc., Cambridge, Mass.
SPECIAL STUDIES OF AROD SYSTEM CONCEPTS AND DESIGNS
D. Bradley Crow 14 Jul. 1967 66 p refs
(Contract NAS8-20128)
(NASA-CR-61669; G-69-TR-3; TR-3) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Discussed are alternate designs for the AROD ground station direction finding receiver. Evaluated are phase metering circuits, methods of selection and switching of RF signals, and the generation of timing and other control signals. Two fundamental receiver designs are presented, both of which utilize local oscillator signals for removal of doppler. G.G.

N68-20115*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
ENCODING INDEPENDENT SAMPLE INFORMATION SOURCES
John T. Pinkston, III 31 Oct. 1967 89 p refs
(Grant NsG-334; Contract DA-28-043-AMC-02536(E))
(NASA-CR-93764; TR-462) CFSTI: HC $3.00/MF $0.65 CSCL 09D

The theory of encoding memoryless information sources so that the output can be transmitted with minimum rate and still satisfy a fidelity criterion based on a single letter distortion measure is investigated. A general proof of the Source Coding theorem for memoryless sources and single letter distortion measures is presented using variable length codes. It is also shown that the convergence of encoder rate to R(D) (the minimum rate necessary to achieve average distortion D) with increasing block length n, can be made at least as fast as (log n)/n. Equivalent theories of source coding are developed for cases in which: (i) the fidelity criterion requires every letter to be reproduced with less than a fixed distortion, rather than merely achieving this performance on the average; (ii) there are several fidelity criteria that must be satisfied simultaneously; and (iii) the source outputs are corrupted by a noisy channel before being furnished to the encoder. Means of calculating or estimating R(D) for sources with a difference distortion measure are developed by showing conditions under which R(D) is equal to a more easily calculable lower bound developed by

Shannon. Even when equality does not hold, we show that R(D) approaches this bound as D→0 for all continuous sources, and that for discrete sources, there is always a nonzero region of small D where there is equality. R(D) for a discrete source and distortion measure $d_{ij}=1-\delta_{ij}$ is calculated exactly for all D, thereby allowing calculation of the minimum achievable symbol error probability when transmitting over a channel of given capacity. Finally, as an application of the theory, we examine quantizers as a class of source encoders, and show that the rate (output entropy) and distortion of such devices is bounded away from R(D), but is usually quite close. Author

N68-20123# Selenia S. P. A., Rome (Italy).
ELDO INITIAL PROGRAM: TASK DEFINITION TD/8 10. ANTENNA DECOUPLING MEASUREMENTS ON THE ELDO VEHICLE SCALED MODEL (1/13,5): F-6/1 CONFIGURATION
Paris ELDO 10 Nov. 1967 145 p Prepared for ELDO
(ELDO-RFI-GA; TR-67/55F) CFSTI: HC $3.00/MF $0.65

This report describes the mutual coupling measurements made on the antennas mounted on the ELDO vehicle body, in the F-6/1 configuration and at the frequencies below 500 MHz. The antennas and the vehicle body are scaled by the factor 1:13.5. Since the only difference between F-6/1 and F-5 configuration is the turnstyle antenna on the satellite, this report concerns the coupling measurements between the turnstyle antenna and all the other antennas. Author (ESRO)

N68-20128# Air Force Cambridge Research Labs., Bedford, Mass. Microwave Physics Lab.
A LARGE DYNAMIC RANGE MICROWAVE POWER MEASUREMENT SYSTEM EMPLOYING FEEDBACK
William B. Goggins, Jr. Oct. 1967 26 p ref *Its* Instrumentation Paper No. 132
(AFCRL-67-0586; AD-665124)

Accurately measuring low level microwave signals over a large dynamic range presents many problems to instrumentation engineers. This is especially true if the measurements must be made at high speeds, as is the case when measuring radar cross sections. This paper discusses several systems for measuring low level microwave signals that are rapidly varying in power. The technique of designing a servo-controlled balanced-measurement system is discussed in detail and an experimental system is described. Author (TAB)

N68-20141# Naval Air Systems Command, Washington, D. C.
HANDBOOK INSTRUMENT CALIBRATION PROCEDURES: AUDIO FREQUENCY DECODERS KY-432/SRM-3 AND KY-433/SRM
15 Apr. 1967 22 p supersedes PB-170940
(NAVAIR-17-20BCK-7; PB-177041; PB-170940) CFSTI: HC $3.00/MF $0.65

These procedures describe the calibration of Audio Frequency Decoder KY-432/SRM-3 and KY-433/SRM. The KY-432/SRM-3, which is contained in Target Control System Test Set AN/SRM-3, is a fixed-wing decoder capable of decoding the first twenty IRIG audio-frequency tones. Author

N68-20142# Bureau of Naval Weapons, Washington, D. C.
HANDBOOK INSTRUMENT CALIBRATION PROCEDURES: AMPLIFIER-FREQUENCY MULTIPLIER AM-3311/SRM AND RADIO RECEIVER R-1135/SRM
15 Apr. 1967 21 p
(NAVAIR-17-20BCK-5; PB-177097) CFSTI: HC $3.00/MF $0.65

The procedures describes the calibration of the Amplifier-Frequency Multiplier AM-3311/SRM (including its Power Supply PP-3373/SRM) and Radio Receiver R-1135/SRM. Author

N68-20143# Bureau of Naval Weapons, Washington, D. C.
HANDBOOK INSTRUMENT CALIBRATION PROCEDURES: TRANSMITTER TEST SET TS-1753/SRM-2
15 Apr. 1967 14 p Supersedes PB-170939
(NAVAIR-17-20BCK-4; PB-177098; PB-170939) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of Transmitter Test Set TS-1753/SRM-2. The TS-1753/SRM-2, herein referred to as the Test Instrument, tests the subassemblies contained in Radio Transmitter T-775/URW-14 and Radio Transmitter T-775/URW-14A. The Test Instrument provides the necessary voltages, dummy loads, controls, and indicators to individually test each transmitter subassembly. Author

N68-20170# Bureau of Naval Weapons, Washington, D. C.
HANDBOOK INSTRUMENT CALIBRATION PROCEDURES: AUDIO FREQUENCY CODERS KY-430/SRM AND KY-431/SRM
15 Apr. 1967 16 p Supersedes PB-170884
(NAVAIR-17-20BCK-6; PB-177096; PB-170884) CFSTI: HC $3.00/MF $0.65

These procedures describe the calibration of Audio Frequency Coder KY-430/SRM and KY-431/SRM. The KY-430/SRM, which is contained in Target Control System Test Set AN/SRM-2 and AN/SRM-5, is a fixed-wing coder that generates the first twenty IRIG audio-frequency tones. These audio-frequency tones, when selected in various combinations represent fixed-wing drone aircraft commands. Author

N68-20182# Mitre Corp., Bedford, Mass.
PLAN FOR SYSTEMS ENGINEERING OF THE NRD TRANSMISSION SYSTEM
O. Cardinale Jan. 1968 40 p refs
(Contract AF 19(628)-5165)
(MTR-434; ESD-TR-67-396; AD-665118)

A proposed systems engineering plan is presented which would be used as a guide in accomplishing systems analysis and engineering to support the NRD Data Transmission System Improvement Program. The need to relate specific performance parameters of the NRD data transmission systems to the mission effectiveness of the range users is emphasized together with the need for a better understanding of the system users requirements. Author (TAB)

N68-20191# Hawker Siddeley Dynamics, Ltd., Stevenage (England).
ELDO INITIAL PROGRAM: TASK DEFINITION TD/8 10. R.F.I. MEASUREMENTS CARRIED OUT ON THE EMU F4 BUILD AT STEVENAGE, DURING THE PERIODS 15–31 MARCH AND 15 JUNE–1 JULY 1968
J. Kerr, comp. Paris ELDO 1 Sep. 1968 124 p Prepared for ELDO
(ELDO-RFI-3) CFSTI: HC $3.00/MF $0.65

This report deals with radio frequency interference measurements on the E.M.U. (electrical mockup) system for the ELDO launch vehicle assembled in F-5 configuration. The equipment and the tests for Wrebus receivers desentization are described and results are given. Author (ESRO)

N68-20193# Selenia S.P.A., Rome (Italy).
ELDO INITIAL PROGRAM: F-5 MULTISTAGE VEHICLE. RADIO INTERFERENCE THEORETICAL STUDY

Paris ELDO 18 May 1967 157 p Prepared for ELDO
(ELDO-RFI-4; TR-67/359) CFSTI: HC $3.00/MF $0.65

The main r.f. characteristics of the ELDO vehicle in the F-5 configuration are recalled and the operating and spurious frequencies of transmitters are analyzed. Path attenuations between possible interfering transmitters and receivers are investigated in order to ascertain preventive and corrective actions to be assumed to avoid receivers desensitization, particularly what concerns the Wrebus receiver. Possible risks of Wrebus threshold deterioration will be remarked owing to P.T.I. PCM/PM telemetry transmitter, if no appropriate corrective actions will be foreseen. Author (ESRO)

N68-20213# RAND Corp., Santa Monica, Calif.
SATELLITES AND TECHNOLOGY FOR COMMUNICATIONS: SHAPING THE FUTURE
J. L. Hult Jan. 1968 31 p refs Presented at the Intern. Symp. on Satellite Commun., Zurich, 24–27 Apr. 1968
(P-3760; AD-664877)

An outline of some technological possibilities and alternatives for communications, emphasizing the use of satellites. This involves estimating capabilities that are technologically feasible together with the comparative costs for acquiring them. The objective is to expose interesting possibilities in the field of communications and to stimulate consideration of the social changes that may accompany the acceptance of various alternatives. Author (TAB)

N68-20214# Sperry Rand Research Center, Sudbury, Mass.
UTILITY OF QUANTIZED MODELS OF FADING FOR ERROR ANALYSIS Final Report, 1 Sep. 1966–31 Aug. 1967
Martin Cohn Jan. 1968 46 p refs
(Contract F19628-67-C-0050)
(SRRC-CR-68-1; AFCRL-68-0033; AD-665135)

The report describes the derivation and use of Markov processes for predicting the performance of block-codes over channels subject to correlated disturbances. The feasibility of computing meaningful measures of performance, using a discrete Markov approximation to the channel statistics, is demonstrated. Author (TAB)

N68-20232# Navy Underwater Sound Lab., New London, Conn.
TIME CODE TECHNIQUES IN SIGNAL PROCESSING AND CONTROL APPLICATIONS
Thomas R. Finnegan 17 Nov. 1967 46 p ref
(USL-846; AD-664652)

Information on time code and time control systems is presented. Elementary time code principles are reviewed, and a unique time control system developed is described. Methods and applications of time and parameter coding that are pertinent to the fields of signal acquisition and signal processing are discussed. Author (TAB)

N68-20280*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SUMMARY OF THE RESULTS OF FEASIBILITY STUDIES OF DIRECT VOICE BROADCASTING UNDERTAKEN FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
P. W. Kuhns, P. Ramins, and G. J. Chomos Washington 1968 16 p refs To be presented at the Intern. Radio Consultive Comm. Meeting, Palma, Spain, 26 Apr.–8 May 1968
(NASA-TM-X-52409) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Direct voice broadcasting studies were conducted (1) to determine the feasibility of direct broadcast of voice programs from an unmanned satellite (with a minimum expected life of two years) to home receivers in the early 1970s, (2) to evaluate the technological requirements of such a mission and the advances required in existing technology and (3) to determine the cost factors. Three frequency bands are considered: 15 to 25 MHz to broadcast for a minimum of one hour to selected areas on a daily repeat basis; 88 to 108 MHz to broadcast simultaneously to home receivers in the United States for 22 hours daily; and 470 to 890 MHz to broadcast audio material to unmodified UHF television sets. The technological status and necessary lead time are discussed for such subsystems as the solar arrays, antennas, thermal control systems, transmitter output devices, and attitude control and stationkeeping systems. Measurements of man-made noise were also taken to aid in determining spacecraft power requirements. Cost effectiveness was measured against similar terrestrial systems, and operating cost per hour was estimated. B.S.D.

N68-20267*# General Dynamics/Convair, San Diego, Calif.
FEASIBILITY STUDY OF LARGE SPACE ERECTABLE ANTENNAS. VOLUME 4: STUDY, PARABOLIC EXPANDABLE TRUSS ANTENNA EXPERIMENT
23 Feb. 1968 557 p refs
(Contract NASw-1438)
(NASA-CR-93837; GD/C-DCL-67-002, V. 4) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A detail analysis of the 100 ft parabolic antenna experiment is presented. During the deployment, adjustment, and test phase, the Apollo is docked to the feed. The antenna has an independent transmitter, receiver, telemetry, station keeping, attitude control, and power system. Specific potential problem areas were evaluated in greater detail to determine solutions. Elements of the antenna were fabricated and tested. A 6.1 ft. diameter scale model of the antenna was tested on the RF range and demonstrated predicted beamwidth and gain up to the maximum test frequency of 15 GHz. Astronaut support in erection, adjust, and test conduction was developed in an operational plan. Fabrication and test sequency plan is outlined and a preliminary program cost of $27.3 million is indicated for a 100 ft. dia. antenna experiment that could be launched 34 months from go-ahead. Author

N68-20304*# General Dynamics/Convair, San Diego, Calif.
FEASIBILITY STUDY OF LARGE SPACE ERECTABLE ANTENNAS. VOLUME 3: SUMMARY, PARABOLIC EXPANDABLE TRUSS ANTENNA EXPERIMENT
22 Jan. 1968 32 p
(Contract NASw-1438)
(NASA-CR-93833; GD/C-DCL-67-002, V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A Saturn-launched experiment is proposed in which a large 100-ft parabolic expandable truss antenna would be deployed, preferably in synchronous orbit. A 740-sq ft omnidirectional solar cell system is to provide power for the tests performed in the 100 MHz to 6 GHz range, with an expulsion and momentum exchange system to be used for stationkeeping and attitude control. Peripherally-mounted telemetry antennas are to provide continuous data relay to earth. Anticipated support by the Apollo crew is discussed in terms of decision-making, evaluation, and malfunction correction. Primary operating sequence of the experiment is depicted; boost to synchronous equatorial orbit is estimated at approximately 7-1/2 hours. Summary details are given on the packaging, subsystems, radiation pattern measurement, fabrication, and the equipment required by the astronaut to perform the EVA tasks. Weight data are summarized, and primary development tasks are listed. M.G.J.

N68-20311 New Mexico Univ., Albuquerque.
AN ANALYSIS OF THE SIGNAL PROCESSING IN A RADIO ALTIMETER UTILIZING RANDOM ANGLE MODULATION
Donald Fay Post (Ph.D. Thesis) 1967 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-6241

This paper presents an analysis of the signal processing in a radio altimeter which transmits a radio-frequency carrier whose phase is varied in a random manner. The signal processing system considered is a multiplier followed by a bandpass filter, a square-law device, a low-pass filter, and a threshold decision circuit. In the general analysis, equations are derived for the distribution density and joint distribution density of amplitude for both the transmitted and received processes. These expressions are applicable for any distribution of the modulating function. In addition, equations are derived for the covariance function and spectrum of the transmitted and received processes subject to the hypothesis that the modulating function is gaussian distributed, and a functional equation is derived for the correlation function at the multiplier output subject to the same hypothesis. In the specific analysis, we apply the results of the general analysis to the problem of deriving equations for the expected value and variance of the output of the low-pass filter. Dissert. Abstr.

N68-20323# Lincoln Lab., Mass. Inst. of Tech., Lexington.
ON THE EQUIVALENCE OF LINEARIZED KALMAN FILTERS
M. Athans 11 Jan. 1967 26 p ref
(Contract AF 19(628)-5167)
(TN-1967-6; ESD-TR-67-20; AD-646550)

The purpose of this note is to examine the relationships of the Kalman filters which can be used to estimate the linearized state of two different state-variable representations of the same nonlinear system. It is shown that, to within first order effects, the choice of the coordinate system for the construction of the Kalman filter is immaterial. Author (TAB)

N68-20333*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE INPUT ADMITTANCE OF A RECTANGULAR APERTURE ANTENNA LOADED WITH A DIELECTRIC PLUG
Calvin T. Swift and Douglas M. Hatcher Washington Apr. 1968 27 p refs
(NASA-TN-D-4430) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A waveguide-fed rectangular aperture antenna, loaded with a dielectric plug, is considered as a variational problem. The formulation results in an aperture-admittance expression which contains the self and mutual admittances of the transverse electric waveguide modes TE_{01} and TE_{03}. The theoretical results show that a gross distortion of the aperture field and a significant decrease in the aperture admittance occurs when the plug becomes a resonant cavity for the TE_{03} mode. The input admittance is compared with microwave measurements for the condition in which the external half-space is air. The theory is generally in good agreement with experiment over the entire waveguide band, including the frequency interval around resonance. It is noted that the plug can be used to tune out the susceptance and improve the match of the antenna. Author

N68-20335*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-49, VOLUME 2 FOR THE PERIOD NOVEMBER 1 TO DECEMBER 31, 1967. THE DEEP SPACE NETWORK
31 Jan. 1968 155 p refs
(Contract NAS7-100)
(NASA-CR-93821; JPL-SPS-37-49, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 17B

An overview is presented on the Deep Space Network (DSN) facilities which are responsible for two-way communications with unmanned spacecraft traveling approximately 10,000 miles from earth to interplanetary distances. To increase its capabilities, tracking and navigational accuracy analyses are being performed with the objectives of determining the inherent accuracy of the DSN as a radio navigation instrument for lunar and planetary missions, and to formulate plans for refining this accuracy to its practical limits. Communications engineering and development projects include linear polarization modifications, RF calibration techniques, receiver and transmitter systems, and a multiple-mission telemetry system. High rate telemetry research is discussed in terms of the test code generator used to check various parts of the telemetry demodulator or the entire telemetry function of a tracking station, cross-correlator field set construction, the telemetry system verification test procedure, and the reference jitter degradation of the error rate. Facility operations and engineering projects are also discussed. M.G.J.

N68-20348# Hawker Siddeley Dynamics, Ltd., Stevenage (England). Command and Tracking Group.
ELDO INITIAL PROGRAM: RFI MEASUREMENTS CARRIED OUT ON THE EMU F6/1 BUILD AT STEVENAGE DURING FEBRUARY 1967
D. E. Campbell, comp. Paris ELDO 13 Mar. 1967 53 p Prepared for ELDO
(ELDO-RFI-6; LX-272) CFSTI: HC $3.00/MF $0.65

The test results of desensitization of Wrebus receivers by various carrier wave signals, the 137.9 Mc/s beacon transmitter and integrated S.T.V. transmitters are tabulated. Tests were also carried out on desensitization of the S.T.V. telecommand receiver by the 3rd stage and S.T.V. V.H.F. transmitters and the results are given in tabular form. Results of desensitization tests on the guidance transponder receiver using the 4 KMc/s sender in the S.T.V. and the two radar transponder transmitters in the 2nd stage are presented. Finally, the results of multicoupling tests using the vehicle transmitters and those of V.S.W.R. measurements on Wrebus and S.R.D.E. aerials are given. Author (ESRO)

N68-20399# Environmental Science Services Administration, Boulder, Colo. Inst. for Environmental Research.
SIGNAL AMPLITUDE DISTRIBUTION FOR STATIONARY RADIO MULTIPATH CONDITIONS
Martin Nesenbergs Aug. 1967 85 p refs
(IER-44-ITSA-44) GPO: $0.50

A physically motivated model for phase interference fading deals with single samples (random variables) of a strictly stationary process and consists of an arbitrary number of statistically mutually independent random vectors. Each vector has a uniform phase, and an amplitude that obeys the Nakagami–Rice distribution. Only vector families of finite total variance (energy) are permitted. Any sum of such vectors is resolved into a sum of a unique scatter vector, plus a number of specular vectors. A central limit theorem is presented that postulates necessary and sufficient conditions under which convergence to a Rayleigh distribution would take place. The speed of convergence to the Rayleigh limit is described in a natural, spherically symmetric way, and an arbitrary probability density function is represented as a weighted series of the derivatives of the Rayleigh kernel, which leads to Laguerre polynomials. The distribution functions and probability density functions of the amplitude of random vectors sums are scrutinized, with particular emphasis on bounds and asymptotic behavior. The performance characterization of selected ideal digital communication systems is given. Author

N68-20406# Auerbach Corp., Philadelphia, Pa.
SOURCE DATA AUTOMATION Final Report
16 Jan. 1967 259 p refs
(Contract CST-307)
(Rept.-1392-200-TR-1; PB-176911) CFSTI: HC $3.00/MF $0.65

Source Data Automation (SDA) is the technique for capturing data at its most immediate source of origin—data which is then converted into, and processed in, a particular format or code. Processing equipment has gone through rapid stages of development

and is in a far more advanced state than input or output equipment; such a differential between central and peripheral operation is a large source of computer inefficiency. By further automation of input and output, this inefficiency can be reduced and the processor used to greater potential. While automating peripheral equipment may improve an individual system, in itself, it cannot guarantee greater intersystem efficiency. Without standards or conventions with respect to equipment features such as keyboard layouts, character sets, codes, functional controls, and design features affecting the transfer of prepared data from one system to another, incompatibility will result. Author

N68-20418# Centro di Studio per la Fisica della Microonde, Florence (Italy).
MODIFICATIONS ON MAGNAVOX MODEL 8 RECEIVER
P. F. Checcacci and R. Traniello Gradassi Jul. 1964 39 p refs
(CH-R15-2.4) CFSTI: HC $3.00/MF $0.65

The improvements made to a Magnavox mod. 8 receiver and the results obtained are described, together with practical details of how these results have been achieved. Doppler measurements and NBFM reception have been performed by adding a new printed circuit unit to those previously existing. Performance and specifications of the new circuit are described. Author (ESRO)

N68-20419# Centro di Studio per la Fisica delle Microonde, Florence (Italy).
DIGITAL TECHNIQUES IN SPACE COMMUNICATION [TRANSMISSIONI NUMERICHE SPAZIALI]
V. Cappellini Feb. 1967 79 p refs In ITALIAN
(CM-R46-10.5) CFSTI: HC $3.00/MF $0.65

The essential features of digital techniques of data transmission for space use, centering around multiplex systems, are discussed. ESRO

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N68-19523# Stanford Univ., Calif. Dept. of Computer Science.
THE USE OF TRANSITION MATRICES IN COMPILING
D. Gries 17 Mar. 1967 63 p refs Sponsored in part by AEC
(CS-TR-57; PB-176765) CFSTI: HC $3.00/MF $0.65

The construction of efficient parsing algorithms for programming languages has been the subject of many papers in the last few years. Techniques for efficient parsing and algorithms which generate the parser from a grammar or phrase structure system have been derived. Some of the well-known methods are the precedence techniques of Floyd, and Wirth and Weber, and the production language of Feldman. Perhaps the first such discussion was by Samelson and Bauer. There the concept of the push-down stack was introduced, along with the idea of a transition matrix. A transition matrix is just a switching table which lets one determine from the top element of the stack (denoting a row of the table) and the next symbol of the program to be processed (represented by a column of the table) exactly what should be done. Either a reduction is made in the stack, or the incoming symbol is pushed on to the stack. Considering its efficiency, the transition matrix technique does not seem to have achieved much attention, probably because it was not sufficiently well-defined. The purpose of this paper is to define the concept more formally, to illustrate that the technique is very efficient, and to describe an algorithm which generates a transition matrix from a suitable grammar. The report also describes other uses of transition matrices besides the usual ones of syntax checking and compiling. Author

N68-19526# Stanford Univ., Calif. Dept. of Computer Science.
RECURSIVE FUNCTIONS OF REGULAR EXPRESSIONS IN LANGUAGE ANALYSIS
Vincent Tixier 20 Mar. 1967 152 p refs Sponspred by AF
(CS-TR-58; PB-176766) CFSTI: HC $3.00/MF $0.65

Notations and conventions; Strings; Regular expressions; Analysis of regular sets; Application to programming languages; Extensions of RCF languages. Author

N68-19583# System Development Corp., Santa Monica, Calif.
A FLEXIBLE LANGUAGE DESIGNED FOR COMPUTER-HUMAN INTERACTION
Samuel L. Feingold 11 Oct. 1967 20 p refs
(Grant NSF GY-371)
(SP-2840; PB-176531) CFSTI: HC $3.00/MF $0.65

The paper discusses a new programming language, PLANIT, designed to handle problems encountered in using time-sharing systems. Computer Human Interaction (CHI) will become economically feasible in the near future with the use of time-sharing systems; PLANIT is a language designed for CHI. Typical programs that would fall into the area of CHI are: computer-assisted instruction, complex desk calculations, completion of employment questionnaires, counseling interviews, on-line training, etc. Programs of this type need the following basic capabilities: (a) ability to specify textual data for presentation to user; (b) ability to specify anticipated responses of the user; and (c) ability to analyze these responses. PLANIT has these capabilities; it is designed to allow the nonprogrammer to construct interactive programs efficiently, quickly, and easily. In addition, the language incorporates a calculational capability for processing mathematical data. Author

N68-19809# Texas Univ., Austin. Coll. of Business Administration.
THE CHANGING ROLE OF SPACEBORNE COMPUTERS IN MANNED MISSIONS
Thomas E. Burke Aug. 1967 9 p refs
(Rept.-67-15)

Studies of potential missions for the post Apollo period indicate demands for increased computing and data processing capability for future manned spacecraft. This trend implies the need for efficient and reliable man–computer communication for long duration missions. Emphasis is on the analysis of future mission requirements and the importance of a close interaction between man and computer in the associated problem solving situations. Although some attention is given to the effect which these requirements have on computer system organization, the paper is not concerned in detail with hardware and software trends. The role of the computer in both Gemini and Apollo is briefly reviewed. Author

N68-19910# Naval Research Lab., Washington, D. C.
A COMPUTER METHOD FOR THE AUTOMATIC REDUCTION OF SPECTROSCOPIC DATA
Earle F. Ditzel and Lorrain E. Giddings, Jr. 18 Jan. 1968 92 p refs
(NRL-6632; AD-665281)

A computer program, for use with an associated spectral comparator, was developed for automatically reducing spectroscopic data. A digitizing magnetic-tape recorder, in conjunction with a microphotometer, allows wavelength and intensity information to be read from a photographic plate at 25 data pairs per second. A computer program written Fortran IV was designed to facilitate processing the information into a usable form. The computer program permits analysis of spectroscopic data by making simple specifications on a control card. Useful features of the program are its capabilities of (a) recognizing spectral peaks from a background of variable density and (b) obtaining absolute values for the radiance or irradiance. The programs essential characteristic is the

significant amount of time saved in reducing photographic spectroscopic data. As a rough estimate of the time-saving advantage, one may obtain thirty times the information in 1/100 of the time, as compared to manual reduction of spectroscopic data. Author (TAB)

N68-19980# RAND Corp., Santa Monica, Calif.
SPECIFICATIONS FOR A NEW JACOBIAN PACKAGE FOR THE RAND CHEMICAL EQUILIBRIUM PROGRAM
Marian Shapely, Leola Cutler, James De Haven, and Norman Shapiro Jan. 1968 54 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5426-PR; AD-664881)

This study describes and gives instructions for using a new and improved Jacobian package consisting of a group of subroutines for RANDs chemical equilibrium program. This new package, which has a much greater scope than the earlier version, computes Jacobian matrices consisting of partial derivatives of certain quantities in the solution of a model (dependent variables) with respect to certain parameters in the model (independent variables). With the use of these derivatives, it is possible to predict how a change in a model parameter can affect the model solution. In many cases the user can obtain a good approximation for how much effect a certain type of change will have without resolving the problem. The derivatives might be used, for example, to see how much the pH of a model might change with an increase in the pressure of carbon dioxide, or with an increase in the amount of sodium hydroxide. Author (TAB)

N68-19986# Illinois Univ., Urbana. Dept. of Computer Science.
EOL PROGRAMMING EXAMPLES: A PRIMER
Leon Lukaszewicz and Jurg Nievergelt 1 Sep. 1967 36 p refs
(Grant NSF GP-4636)
(Rept.-242)

To facilitate the study of the symbol manipulation language EOL, three EOL programs or parts of programs are described in detail. These were taken from the general area of compiler writing which is considered to be the main field of EOL application. Three examples are presented to emphasize the versatility of EOL: transforming arithmetic formulas into parenthesis-free form, generating tables of identifiers for programs with nested block structure, and the use of switches in a compiler. M.G.J.

N68-19991# Massachusetts Inst. of Tech., Cambridge. Electronic Systems Lab.
A LOW-COST GRAPHIC DISPLAY FOR A COMPUTER TIME-SHARING CONSOLE
Robert H. Stotz and Thomas B. Cheek Jul. 1967 32 p refs
(Contract Nonr-4102(01); Proj. Mac)
(ESL-TM-316; AD-664673)

The advent of time-shared computer systems has created a need for a flexible and relatively low-cost communication terminal for remote computer access. Most time-shared systems now use mechanical teletypewriters which are slow and unable to present graphic displays--a serious limitation in many sophisticated computer applications. The best candidate for a teletypewriter replacement appears to be a CRT console with an alphanumeric keyboard input which can connect as a stand alone unit to a standard telephone line. The unit uses a direct-view storage tube (DVST) for a display screen and contains a vector generator and a symbol generator for the full ASCII symbol set. It can connect to a central computer via a 1200-2400 baud dataphone line. A manually-controlled electronic cursor for graphical input to the computer can also be added. Author (TAB)

N68-20029# RAND Corp., Santa Monica, Calif.
ANSWERING QUESTIONS BY COMPUTER: A LOGICAL STUDY
J. L. Kuhns Dec. 1967 138 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5428-PR; AD-664882)

Consider a study of the processing of questions input to a computerized question-answering system such as the RAND Relational Data File (see AD-642 120). The process consists of (1) transforming the natural-language question into a symbolic question (i.e., a certain formula of predicate calculus) and (2) generating the answer by calculating the value set of the resulting formula. This study is addressed to the second step. A key problem is the identification of reasonable input queries. TAB

N68-20104# Illinois Univ., Urbana. Dept. of Computer Science.
A SLIDE SCANNER INPUT FOR PARAMATRIX
Lawrence D. Ryan (M.S. Thesis) 20 Sep. 1967 56 p refs
(Contract N00014-67-A-0305-0007)
(Rept.-249; AD-664669)

A special purpose flying-spot slide scanner was designed to provide an efficient and flexible means for transmitting an input pattern to Paramatrix, a pattern processing computer. The light spot of a CRT is positioned by the horizontal and vertical outputs of the Paramatrix Transformer opposite a test point on the input slide. The presence or absence of light behind the slide is detected by a photomultiplier, and an appropriate logic signal is generated which is used to either light or not light a bulb in the output matrix. Variable horizontal and vertical sensitivity controls have been incorporated into the scanner system. In this manner test points that are near line segments of the input pattern are considered to be part of the input pattern. This feature allows for thinning and thickening the lines of the output pattern. Author (TAB)

N68-20184# Joint Publications Research Service, Washington, D. C.
EXPERIENCE IN MACHINE PROCESSING OF INFORMATION IN PART/TIME SYSTEMS
A. M. Brekhov 19 Mar. 1968 31 p refs Transl. into ENGLISH from the book "Opyt Mashinnoy Obrabotki Informatsii v Sistemakh Spu s Kontrolem po Uremeni" Leningrad, House of Sci.-Tech. Propaganda, 1966 p 3-35
(JPRS-44733) CFSTI: HC $3.00/MF $0.65

Modifications of input information forms and machine output documents are presented for use in an operating PERT (Program Evaluation and Review Technique) system by an industrial plant that manufactures heavy paper-making machinery and employes 5,000 persons. Details are included for the means by which information is being processed and corrections are made; and various technical details for PERT systems are included. Machine algorithms for calculating the parameters of determinate network models are given, as are probabilistic models of operations and jobs to be accomplished. M.W.R.

N68-20197# Illinois Univ., Urbana. Dept. of Computer Science.
QUARTERLY TECHNICAL PROGRESS REPORT, JULY-SEPTEMBER 1967
Sep. 1967 263 p refs
(Contract N00014-67-A-0305-0007)
(COO-1018-1132; COO-1469-0073; AD-664667)

Work is reported in the following areas: (1) *Circuit Research Program*—development of photomultiplier detection circuit for slide scanner, sequential computer coding, and computer developments; (2) *Hardware Systems Research*—on-line Fourier transform system; (3) *Computer System Software Research*—numerical analysis, graphics programming, etc.; (4) *Illinois Pattern Recognition Computer: ILLIAC*

II—programming developments, input–output systems, network, power distribution, etc.; (5) *ILLIAC IV*—reliability analysis, language translator writing system, computer graphics, etc.; (6) *Numerical Methods, Computer Arithmetic and Artificial Languages*—computerized mathematics, algebraic manipulations, etc; (7) *Computational Physics;* (8) *Switching Theory and Logical Design;* (9) *ILLIAC II Service, Use, and Program Development*—library programming, engineering maintenance, etc.; (10) *IBM 7094/1401 Service, Use, and Program Development*—new routines, and log summaries; (11) *Problem Specifications*—research and instructional problem; and (12) General Laboratory Information. G.G.

N68-20245# Informatics, Inc., Bethesda, Md.
A STUDY OF THE REMOTE USE OF COMPUTERS, VOLUME 2. APPENDIX C: COMPUTER PRINTOUTS OF SURVEY DATA Final Report
11 Jan. 1968 149 p
(TR-67-679-1; PB-177221) CFSTI: HC $3.00/MF $0.65

Computer printouts are presented of survey data as part of a study on the use of remote controlled computers. R.N.A.

N68-20292# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
APPLICATION OF THE HOUSE-RADO PROCEDURE TO THE SOLUTION OF CC TABLES
Thomas Charles Darr (M.S. Thesis) Dec. 1967 67 p refs
(GE/EE/67S-6; AD-665130)

A method is developed for obtaining the optimal solution for a CC table. The method is based on concepts developed by House and Rado for a related problem. It also incorporates several well known table reduction rules. The advantage of the method over other techniques, i.e., column branching and Boolean Algebra, is that every solution need not be examined before the optimal is determined. Factors affecting the efficiency of the method are discussed and an example solution of a typical CC table is illustrated. A practical application of the method to the reduction of incompletely-specified sequential machines is included as an appendix.
Author (TAB)

N68-20305# Illinois Univ., Urbana. Dept. of Computer Science.
EOL REPORT
Leon Lukaszewicz and Jurg Nievergelt 1 Sep. 1967 88 p refs
(Grant NSF GP-4646)
(Rept.-241)

Defined as a low-level language for manipulating strings of characters, the EOL program consists of a sequence of macro definitions followed by a sequence of external procedures. The EOL is considered to be the assembly language of a hypothetical EOL computer, which is intended to be simulated on a conventional computer and is therefore a pure software system. Binary fixed-length word computers are considered to be most suitable for simulating the EOL computer. The EOL basic symbols and syntax are given, along with the variables and their values. Instructions for using the program are detailed. M.G.J.

N68-20342# Stanford Univ., Calif. Dept. of Computer Science.
ON CERTAIN BASIC CONCEPTS OF PROGRAMMING LANGUAGES
Niklaus Wirth 1 May 1967 33 p refs
(CS-65; PB-176767) CFSTI: HC $3.00/MF $0.65

Recent developments of programming languages have led to the emergence of languages whose growth showed cancerous symptoms: the proliferation of new elements defined every control exercised by the designers, and the nature of the new cells often proved to be incompatible with the existing body. In order that a language be free from such symptoms, it is necessary that it be built upon basic concepts which are sound and mutually independent. The rules governing the language must be simple, generally applicable and consistent. In order that simplicity and consistency can be achieved, the fundamental concepts of a language must be well-chosen and defined with utmost clarity. In practice, it turns out that there exists an optimum in the number of basic concepts, below which not only implementability of these concepts on actual computers, but also their appeal to human intuition becomes questionable because of their high degree of generalization. The following informational notes do not abound with ready-made solutions, but it is hoped they shed some light on several related subjects and inherent difficulties. They are intended to summarize and interrelate various ideas which are partly present in existing languages, partly debated within the IFIP Working Group 2.1, and partly new. Author

N68-20390# Stanford Univ., Calif. Dept. of Computer Science.
A PROGRAMMING LANGUAGE FOR THE 360 COMPUTERS
Niklaus Wirth 20 Jun. 1967 77 p refs Revised edition
(CS-53; PB-176763) CFSTI: HC $3.00/MF $0.65

A programming language for the IBM 360 computers and aspects of its implementation are described. The language, called PL360, provides the facilities of a symbolic machine language, but displays a structure defined by a recursive syntax. PL360 was designed to improve the readability of programs which must take into account specific characteristics and limitations of a particular computer. It represents an attempt to further the state of the art of programming by encouraging and even forcing the programmer to improve his style of exposition and his principles and discipline in program organization. Because of its inherent simplicity, the language is particularly well suited for tutorial purposes. The attempt to present a computer as a systematically organized entity is also hoped to be of interest to designers of future computers. Author

N68-20395# European Space Vehicle Launcher Development Organization, Paris (France). Engineering Coordination Div.
PROPOSED METHOD FOR GENERAL PROGRAMMING OF A SINGLE COMPUTER FOR PRE-LAUNCH CHECK-OUT
C. Vaugeois Feb. 1967 18 p
(ELDO-TM-E-12) CFSTI: HC $3.00/MF $0.65

The use of a single computer to check-out the ELDO vehicle during the automatic sequence leads to a detailed survey of the programming problems. These problems exist for two reasons: the computer is used 'on line' and by several users. This note proposes in general terms a relatively simple method, based on the use of a priority interrupt system. It allows the different users considerable freedom in the writing of their programs. Further, a description of the work to be done by the computer is available in the annex.
Author (ESRO)

N68-20396# European Space Vehicle Launcher Development Organization, Paris (France). Engineering Coordination Div.
USE OF A DIGITAL COMPUTER FOR PRE-LAUNCH CHECKOUT OF THE ELDO-A VEHICLE
C. Vaugeois Mar. 1967 19 p ref
(ELDO-TM-E-19) CFSTI: HC $3.00/MF $0.65

This note confines itself to the exposure of certain problems related to the digital checkout computer. The explanations given therein should facilitate the actual discussions on the subject. After demonstrating the necessity of a digital computer and the ancillary benefits to be gained from, the paper reviews the principal problems associated with programming by a comparison between a single computer and a multi-computer facility. Author (ESRO)

N68-20443# Centro di Studio per la Fisica delle Microonde, Florence (Italy).
AUTOMATIC READER OF RECORDED DATA [LETTORE AUTOMATICO DI REGISTRAZIONI GRAFICHE]
V. Cappellini and P. F. Checcacci Jul. 1965 14 p refs In ITALIAN
(CM-R23-2.5) CFSTI: HC $3.00/MF $0.65

Analog or digital conversion techniques through automatic photoelectronic scanning of recorded data are examined for satellite transmitted data processing. ESRO

N68-20473# Laboratoire de Recherches Balistiques et Aerodynamiques, Vernon (France).
EXAMPLES OF NUMERICAL PRECISIONS IN THE RESOLUTION OF LINEAR SYSTEMS BY LEAST SQUARES METHOD [EXEMPLES DE PRECISIONS NUMERIQUES DANS LA RESOLUTION DE SYSTEMES LINEAIRES AU SENS DES MOINDRES CARRES]
A. Desgardin 8 Jan. 1968 66 p In FRENCH
(NT-2/EAS-E 1508) CFSTI: HC $3.00/MF $0.65

Presentation and discussion of results gained by 3 different methods of resolving 5 linear systems obtained in the process of analyzing data of wind tunnel tests. ESRO

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N68-19589* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
EXTERNAL VISUAL INSPECTION CRITERIA FOR SEMICONDUCTOR DEVICES
L. C. Hamiter, Jr., M. F. Nowakowski, and C.G. Cole 28 Nov. 1966 33 p
(NASA-TM-X-60946; SR-QUAL-66-21) CFSTI: $3.00 CSCL 09A

Described are minimum acceptable external visual inspection limits for semiconductor devices. Detail visual inspection criteria are presented for five types of semiconductors. These are solid metal header devices, glass filled header devices, stud mounted devices, axial mounted devices, and flat pack devices. S.C.W.

N68-19701*# Electro-Optical Systems, Inc., Pasadena, Calif.
PRESSURE SWITCH FOR DETECTION OF THRUSTER OPERATION OF LUNAR EXCURSION MODULE REACTION CONTROL SYSTEM Final Report
J. Delmonte 10 May 1967 141 p
(Contract NAS9-6409)
(NASA-CR-93767; EOS-7127-Final) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Information is presented on the construction of rugged, low pressure threshold, miniature electronic pressure switches designed to withstand combustion pressures of reaction control systems and associated severe environmental conditions. Test data are presented to verify high speed of response, high overload protection, and stability during vibratory accelerations. Minor design improvements are proposed. Author

N68-19777# Electro-Optical Systems, Inc., Pasadena, Calif.
CHARGE-CONTROLLED STORAGE DISPLAY PANELS Quarterly Report, 1 Jul.–30 Sep. 1967
D. Paul Foote and Benjamin Kazan Jan. 1968 31 p ref
(Contract DA-28-043-AMC-02482(E))
(EOS-7109-Q-5; ECOM-02482-5; QR-5; AD-664776)

During the quarter the characteristics and performance of image storage panels were evaluated. Development continued on techniques for production of plastic panels, and several small panels were fabricated. Use of a new yellow EL phosphor on conventional panels resulted in better image display under full room illumination. Tests showed that images could be stored and viewed for an hour. Erasing time and a nonelectrical type of erasure were also studied. A new panel design using a plastic support plate without requiring evaporated conductive layers was developed and evaluated. Author (TAB)

N68-19812# Army Electronics Labs., Fort Monmouth, N. J.
GRAPHICAL DESIGN OF COMB-LINE FILTERS
Elio A. Mariani and Michael Liegner Dec. 1967 55 p refs
(ECOM-2906; AD-664752)

A graphical design approach for the comb-line filter is described whereby calculations are facilitated by means of extensive design charts. Design charts for the mutual and self capacitances of the comb-line resonators for the cases of a 0.10 and 0.01 dB Tchebyscheff ripple response (n = 2 to 10) are presented for bandwidths ranging from 1 to 10%. A design example demonstrating the use of the design curves is also inclosed. Author (TAB)

N68-19860# Navy Underwater Sound Lab., New London, Conn.
A NEGATIVE-RESISTANCE MAGNETORESISTIVE CIRCUIT
Milton Green 8 Jan. 1968 31 p refs
(USL-864; AD-665286)

A negative-resistance circuit that consists of a magnetoresistor situated in the magnetic field produced by two magnetomotive forces (MMFs) is described. The winding of one of the MMFs is connected serially with the magnetoresistor. The negative-resistance region is determined by the condition b-B > dB/d lnRm, where B is the magnetic field at the magnetoresistor, b is the bias field (produced by the second MMF alone), and Rm(B) is the magnetic-field dependence of the magnetoresistor. For a quadratic magnetoresistor characteristic, this condition becomes Rm(b) > 4R(0). The negative-resistance characteristics of a superconductor magnetoresistor are presented. Switching of the modes and the stable amplification region of the circuit is discussed. Experimental results for indium antimonide (at 193K) and bismuth (at 4.2K) magnetoresistors are given. Author (TAB)

N68-19885# Army Materials and Mechanics Research Center, Watertown, Mass.
PROBE COILS WITH FERRITE CORES EVALUATED FOR USE IN ELECTROMAGNETIC TESTING
Robert C. Grubinskas Dec. 1967 41 p refs
(AMMRC-TR-67-06; AD-664763)

The results of an evaluation study of absolute-type probe coils with ferrite cores are presented to provide empirical data which is applicable to both the Army Quality Assurance Program and the area of probe coil design. Although the dimensional and electrical characteristics of these probe coils are considered, the main discussion is devoted to the interpretation of the graphical correlations relating their operational characteristics to pertinent coil and test parameters. Author (TAB)

N68-19960# General Electric Co., Owensboro, Ky. Tube Dept.
THREE HUNDRED MILLIWATT X-BAND TRIODE OSCILLATOR Quarterly Report, 1 Jul.–30 Sep. 1967
J. M. Connelly and L. F. Jeffrey Jan. 1968 34 p
(Contract DA-28-043-AMC-01795(E))
(QR-7; ECOM-01795-7; AD-664783)

Thirty-four Y-1613-E triodes were constructed for life testing and to evaluate the effect of different reducing agents on cathode emission. Six Y-1613-G triodes having nickel base cathodes were built and were found to give higher emission and power output, and to be more stable during early life operation. Results using Philips B dispenser cathodes are reported. RF life test results on six triode cavity oscillators are given. Varactor tuning diodes of three different types were evaluated. The maximum frequency deviation obtained was 15 MHz. Author (TAB)

N68-20011# Naval Ammunition Depot, Crane, Ind.
INFORMATION ON MICROELECTRONICS FOR NAVY EQUIPMENTS
2 Jan. 1968 268 p *Its* Mu-Notes No. 22
(AD-664947)

Information is presented on evaluation, application, availability, research and development, and standardization activity pertaining to state-of-the-art microelectronic circuits, devices, and materials, with a view toward avoiding duplication of effort and making maximum use of technical resources. TAB

N68-20075# Carnegie-Mellon Univ., Pittsburgh, Pa. Electrical Engineering Dept.
THE REALIZATION OF A WIDE BAND GAP EMITTER TRANSISTOR Interim Technical Report
Dale K. Jadus Oct. 1967 137 p refs
(Contract DA-31-124-ARO(D)-131)
(AROD-3397.22-E; AD-664784)

A Ge-GaAs wide band gap emitter transistor was realized that exhibits useable current gain. Useable current gains of about 15 are observed in a structure with an n-GaAs wide band gap emitter and a p-n Ge base-collector region at current densities up to 3500 A/sq cm. A typical device has a collector doping of 10 to the 16th power/cu cm, a 1 to 2 micron wide strongly graded diffused base with a maximum doping level of 5 . 10 to the 19th power/cu cm, and a thin emitter doped to 5 . 10 to the 16th power/cu cm. The attainment of current gain in a structure with the base region more heavily doped than the wide band gap emitter region is in agreement with Kroemers Wide Band Gap Emitter theory. A heterojunction transistor with a heavily doped and low resistance base region in conjunction with a more lightly doped emitter region has two distinct advantages over a comparable gain homojunction transistor. Both the emitter capacitance and transverse voltage drops are reduced resulting in possible improvements in high frequency performance and uniformity of current distribution in the device. Author (TAB)

N68-20149# TRW Systems Group, Redondo Beach, Calif.
INVESTIGATION OF RADIATION HARDENED CIRCUIT ELEMENTS
D. A. McWilliams and L. C. Davis 15 Nov. 1967 49 p refs
(Contract F19628-67-C-0262)
(AFCRL-67-0684; SR-2; AD-664922) CFSTI: HC $3.00/MF $0.65

An investigation was made of hardened insulated-gate field effect devices. Included are a review of MOS transistor theory, a derivation of MOS characteristics as a function of substrate bias, and the early results in the fabrication of complementary enhancement pairs. These devices, made in Czochralski silicon 3 microns thick, are fabricated by processes compatible with normal MOS integrated circuit procedures. The early pairs have poorly matched thresholds and low transconductance on the N-enhancement devices. Breakdown voltages were in excess of 40 volts for both P and N devices. The P device has characteristics like discrete P-enhancement devices. A blocking diffusion is used to provide a barrier to surface inversion in the N device without increasing device junction areas. Dielectrically isolated MOS integrated circuits can offer significant advantages in certain circuit applications. The major advantage accrues due to individually biased substrate regions for each active device. This allows certain simplifications in MOS circuit designs expanding the range of operation and optimizing gain characteristics. For this reason, a theory of MOS operation as a function of substrate bias was derived and is presented in this report. Author (TAB)

N68-20252# Watkins-Johnson Co., Palo Alto, Calif.
INVESTIGATION OF LOW WEIGHT FOCUSING SCHEMES FOR TRAVELING-WAVE TUBE AMPLIFIERS Final Report, 15 Jul.–29 Oct. 1967
J. N. Nelson Jan. 1968 46 p refs
(Contract DA-28-043-AMC-02578(E))
(ECOM-02578-F; Rept.-4; AD-664782)

The report describes the end results on a program concerned with the investigation of lightweight focusing schemes for low-noise TWT amplifiers. This involved the study of both hollow beam and solid beam low noise tubes. Hollow beam tubes with their inherent high gamma-A, low helix voltage, and short beam length are more suitable for PM focusing. Solid beam tubes with their relatively low gamma-a, high helix voltage and long beam length are more amenable to reversed field focusing. A significant reduction in size and weight of these amplifiers was achieved without compromising the noise figure. This was accomplished by the development of miniaturized, short beam length tubes. A concommitant reduction in tubular magnet size and weight, and the use of new and improved magnetic materials. Author (TAB)

N68-20274# Siliconix, Inc., Sunnyvale, Calif.
DESIGN AND DEVELOPMENT OF RADIATION HARDENED FIELD-EFFECT TRANSISTORS Final Report, 30 Jun. 1964–30 Nov. 1966
Frederick Zieber 1967 113 p
(Contract DA-04-200-AMC-725(X))
(Rept.-1; AD-664794)

The effects of fast neutron radiation on field-effect transistors was studied, and a theory consistant with actual data was developed. In particular, junction FETs with high pinchoff voltage and with heavier channel-carrier concentration are more radiation resistant. For MOS FETs, low substrate carrier concentration provides better radiation resistance. Three radiation-resistant devices were developed: an n-channel junction FET, a p-channel junction FET, and an n-channel depletion MOS FET. The junction FETs showed less parameter degradation than the MOS after 10 to the 15th power nvt; however the MOS was still functional after extremely high radiation --- 3 x 10 to the 16th power nvt. Author (TAB)

N68-20407# Centro di Studio per la Fisica delle Microonde, Florence (Italy).
SPACE ELECTRONICS: TWO TELEMETRY CALIBRATION SETS, PULSE MODULATION GENERATOR FOR TRANSMITTERS [ELETTRONICA SPAZIO: DUE TIPI DI CALIBRATORI TELEMETRICI, MODULATORE IMPULSIVO PER TRASMETTITORE]

P. F. Checcacci and P. F. Pellegrini Mar. 1964 19 p In ITALIAN
(CM-R14-2.3) CFSTI: HC$3.00/MF$0.65

Two simple calibration circuits, for data transmission in telemetry and a pulse modulation generator for transmitters, are described. ESRO

N68-20412# Associated Universities, New York.
DESCRIPTION OF MULTICONDUCTOR BOARD
Arthur M. Shalloway 13 Oct. 1966 4 p
(Contract NSF C-50)
(PB-176904) CFSTI: HC$3.00/MF$0.65

The multiconductor board described here is intended to eliminate some of the time and cost problems that have plagued printed circuit boards. Author

N68-20422 Central Lab. for Radiological Protection, Warsaw (Poland).
DESIGN CRITERIA FOR MOSFET PORTABLE IONIZATION CHAMBER MONITORS [ZASADY PROJEKTOWANIA PRZENOSNYCH MONITOROW NA TRANZYSTORACH Z IZOLOWANA BRAMKA]
W. Katkiewicz 1967 32 p refs
(CLOR-67/D) CFSTI: $3.00

The design criteria and operating mechanisms are given for MOSFET portable ionization chamber moniters. The performances of the MOSFET in electrometer applications is discussed in relation to the input voltage, drain current, initial and long-term drifts associated with ion motion in the insulator, and temperature performances. The selection criteria for the input MOSFET are delineated, and the development of a direct coupled amplifier is considered. Equations are given for calculating the differential output voltage caused by the temperature change, time drift, and supply drift. Circuit diagrams of the various components of the monitor are included. B.S.D.

N68-20441# Centro di Studio per la Fisica della Microonde, Florence (Italy).
SAWTOOTH VOLTAGE GENERATORS WITH UNIJUNCTION TRANSISTORS [GENERATORI DI TENSIONI A DENTI DI SEGA CON TRANSISTORI UNIGIUNZIONE]
V. Cappellini and P. F. Checcacci Sep. 1964 54 p refs In ITALIAN
(CM-R17-4.5) CFSTI: HC$3.00/MF$0.65

High linearity, stable high tension generator circuits assembled with unijunction transistor relaxation oscillators and their characteristics are described. ESRO

N68-20444# Centro di Studio per la Fisica della Microonde, Florence (Italy).
SPACE ELECTRONICS: LINEAR DETECTOR, SUB-CARRIER FREQUENCY METER [ELETTRONICA SPAZIO: RIVELATORE LINEARE, FREQUENZIMETRO DISCRIMINATORE PER SUB-CARRIEA]
P. F. Checcacci and P. E. Pellegrini Mar. 1964 23 p refs In ITALIAN
(CM-R13-4.4) CFSTI: HC$3.00/MF$0.65

This paper exposes the theory of linear detectors and describes a sub-carrier frequency meter. ESRO

N68-20472# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati.
MULTICHANNEL DIGITAL TIMERS
J. E. van Montfoort and R. J. Verbeek Jul. 1967 37 p refs Sponsored in part by EURATOM
(LGI-67/15) CFSTI: HC$3.00/MF$0.65

A description is given of several digital timers constructed in our laboratory. They are used as multichannel trigger sources for the precise timing of one-shot experiments. The use of digital techniques and the availability of logic elements in building-brick form permit a rapid realization of reliable timing systems with a precision which would be very difficult to obtain with analog techniques. In most recent models use is made of integrated circuits. Author (ESRO)

N68-20488# Laboratoire de Recherches Balistiques et Aerodynamiques, Vernon (France).
SET OF FREQUENCY SYNTHESIZERS AND DIVIDERS [ENSEMBLE DES PILOTES ET DIVISEURS]
Guy Feuerstein 7 Dec. 1967 58 p In FRENCH
(NT-70/67/EG) CFSTI: HC$3.00/MF$0.65

Description is made of the crystal controlled frequency generators and frequency dividers associated to the electronic control equipment of the 60 g centrifuges. ESRO

N68-20518# Centro di Studio per la Fisica delle Microonde, Florence (Italy).
INPUT IMPEDANCE OF SHORT DIPOLAR ANTENNAS ON A NIKE–APACHE ROCKET VEHICLE [IMPEDENZA DI INGRESSO DI ANTENNE DIPOLARI CORTE SU UN RAZZO NIKE–APACHE]
G. Ventura Nov. 1966 30 p refs In ITALIAN
(CH-R39-10.4) CFSTI: HC$3.00/MF$0.65

A set of measurements of the impedance of a short dipolar antenna when fixed on a Nike–Apache rocket vehicle scale model is described. The values in these conditions are slightly superior to the calculated value for the same antenna in the void. ESRO

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N68-19633# Joint Publications Research Service, Washington, D. C.
ON THE PROBLEM OF THE INVESTIGATION OF THE FUNCTIONING STABILITY OF COMPLEX SYSTEMS
V. V. Kalashnikov 22 Mar. 1968 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), no. 6, 1967 p 1294–1297
(JPRS-44778) CFSTI: HC$3.00/MF$0.65

It is pointed out that in studying the common properties of the individual classes of complex systems, the stability of their functioning is a significant factor. Equations are derived, based on the assumption that the condition of a complex system is described by a set of general coordinates, while the process of its functioning is determined entirely by the variation of these coordinates in time, i.e., by the functions which generally comprise the realizations of a certain random process. Author

N68-19711 Joint Publications Research Service, Washington, D. C.
CYBERNETICS, CONTROL THEORY AND MECHANICS
22 Mar. 1968 16 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), no. 4, 1967 p 796–803
(JPRS-44777) CFSTI: $3.00

CONTENTS:

1. CONCERNING THE ASYMPTOTIC INTEGRATION OF THE EQUATIONS OF A CONTROLLED PROCESS K. A. Abgaryan p 1–6 refs (See N68-19712 10-10)

2. CONTRIBUTION TO THE QUESTION OF THE OPTIMIZATION OF THE SYNTHESIS OF TECHNOLOGICAL MACHINE AUTOMATIC DEVICES I. I. Artobolevskiy p 7–13 refs (See N68-19713 10-10)

N68-19712 Joint Publications Research Service, Washington, D. C.

CONCERNING THE ASYMPTOTIC INTEGRATION OF THE EQUATIONS OF A CONTROLLED PROCESS

K. A. Abgaryan *In its* Cybernetics, Control Theory and Mech. 22 Mar. 1968 p 1–6 refs (See N68-19711 10-10)

Mathematical models are evolved for the asymptotic integration of the equations of a controlled process in a linear transformation. It is assumed that the elements of the matrices are slowly changing functions, and the eigenvalues are divided into groups so that quadratic matrices can be constructed. An integral transformation is performed, and recurrent relationships are found that permit the series to be determined sequentially. M.W.R.

N68-19713 Joint Publications Research Service, Washington, D. C.

CONTRIBUTION TO THE QUESTION OF THE OPTIMIZATION OF THE SYNTHESIS OF TECHNOLOGICAL MACHINE AUTOMATIC DEVICES

I. I. Artobolevskiy *In its* Cybernetics, Control Theory and Mech. 22 Mar. 1968 p 7–13 refs (See N68-19711 10-10)

Synthesis of the optimal variant for commonly-used automatic machines used in mass production industries is considered. An assembly process is detailed with the aid of operators, two stages in production are distinguished, and an operational equation for an automatic machine is derived. The use of computerized data processing permits consideration of many variants involved in the automation process. M.W.R.

N68-19738 Rensselaer Polytechnic Inst., Troy, N. Y.

IDENTIFICATION AND CONTROL OF NOISY DISCRETE SYSTEMS

Kenneth W. Jenkins (Ph.D. Thesis) 1966 158 p

Available from Univ. Microfilms: HC $7.40/HC $3.00 Order No. 67-4175

The problem of controlling a system described by a set of difference equations when some of the system parameters vary from their nominal value is analyzed. The system has both statistical and deterministic disturbances acting upon it. A control is to be synthesized which regulates the state of the system in an optimal fashion, as defined by a quadratic performance index, using only the available noisy measurements. The control system is arbitrarily chosen to comprise a control loop and a parameter identifier. The identifier estimates the unknown plant parameters from normal observations of the plant input and output. The control loop alters its policy in accordance with these new parameter values. The control loop is obtained from a Dynamic Programming derivation which accounts for the deterministic as well as the statistical disturbances. The resulting system is comprised of a least squares state estimator, a feedback gain matrix operating on this estimate and a feedforward input term. Dissert. Abstr.

N68-19790*# Scripta Technica, Inc., Washington, D. C.

PROPERTIES OF GENERALIZED ROOT-LOCI [DIE EIGENSCHAFTEN VERALLGEMEINERTER WURZELORTSKURVEN]

G. Grubel and L. Schmieder Washington Mar. 1968 16 p refs Transl. into ENGLISH of DLR-FB-67-68 Rept. (Contract NASw-1694)

(NASA-TT-F-11516; DLR-FB-67-68) CFSTI: HC $3.00/MF $0.65 CSCL 09C

In this paper generalized root-loci are introduced, which are generated by mapping the polar coordinate lines of the C-plane into the s-plane. C(s) is the system gain which is in its general form complex. By means of the theory of complex functions it is possible to easily derive the essential properties of the root-loci. Furthermore Schwarz's reflection principle can be applied to show that straight lines and circles can be root-loci if and only if the poles as well as the zeros lie symmetrically to these straight lines and circles. From this the symmetrical properties of the root-loci are derived. In addition to the known methods for constructing the root-loci graphically, a method is derived for the stepwise computation of root-loci. The step size is estimated by means of the curvature. The formula of Ur, giving the curvature in regular and simple breakaway points, is generalized. An illustrating example is given. Author

N68-19854 Oklahoma State Univ., Stillwater.

STATE SPACE SYNTHESIS OF PASSIVE ONE PORT NETWORKS

Marvin Emmett Daniel (Ph.D. Thesis) 1966 108 p

Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7211

Several theorems relating an analytical state model to a physical system are formulated and proved. A correlation between the state model and the classical one-port network is developed. A linear transformation of the state variables transforms the coefficient matrix of the state model to the rational canonical form. The elements of the transformed coefficient matrix are found to be the coefficients of the polynomials which represent the input impedance of the network. An algorithm is developed to test the state model for physical realizability. Inspection of the rational and Jordan canonical forms of the coefficient matrix and a short computation provide necessary and sufficient conditions that the state model be realizable as a one-port network. Necessary and sufficient conditions that a state model have a one-port realization composed of inductors and capacitors (LC), resistors and capacitors (RC), or resistors and inductors (RL) are stated and proved. Dissert. Abstr.

N68-19875 Syracuse Univ., N. Y.

APPLICATIONS OF LATTICE THEORY TO THRESHOLD LOGIC

Garth Hillman Foster (Ph.D. Thesis) 1966 134 p

Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-7072

The pertinent results of threshold logic are reviewed and a brief introduction to lattice theory is given. The interpretation of the monotonicities in terms of chains can reduce the effort of checking the conditions leading to complete monotonicity; the Hasse diagram of the lattice of the n-cube provides a useful geometric interpretation of 2-monotonicity and the extensions to 3 and 4-monotonicity are discussed. Logical conditions equivalent to 3 and 4-summability are given and resulting from this the sufficiency of complete monotonicity for threshold realizability may be shown for $n \leq 8$. The n-cube lattice's Hasse diagram is also used as a geometric aid in a heuristic synthesis of two level networks, and additional topics relating to the synthesis of threshold gate networks, their topology and their reliability are discussed. Dissert. Abstr.

N68-19879 Missouri Univ., Rolla.
CONTINUOUSLY TAPERED DIELECTRIC MATCHING TRANSITIONS FOR WAVEGUIDES
William Eugene Hord (Ph.D. Thesis) 1966 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-58

The dissertation provides an analytical method for analysis and design for the continuously tapered dielectric matching transition. The continuously tapered dielectric matching transitions investigated provide increased bandwidth with very little increase of physical complexity. First-order and second-order approximate solutions for both symmetrical cross section and unsymmetrical cross section linearly tapered matching transitions are given. In addition other continuous tapers which promise lower reflection coefficients than the linear tapers are analyzed using the first-order approximation. Dissert. Abstr.

N68-19880# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
STOCHASTIC PROGRAMS IN ABSTRACT SPACES
Richard M. Van Slyke (Calif. Univ., Berkeley), and Roger J.-B. Wets Oct. 1967 41 p refs Supported in part by NSF *Its* Mathematical Note No. 539
(D1-82-0672; AD-664810)

The paper is a continuation of a previous article, Programming under Uncertainty and Stochastic Optimal Control, (AD-618 201), which was limited to linear operators with finite dimensional range; whereas the present paper does not impose such a restriction on the class of admissible operators. In the context of optimal control this means that the theory developed here encompasses control problems whose dynamics are described by partial differential equations as well as control problems with state space constraints. In addition to the derivation of the properties of this problem, one section is devoted to developing in some detail the relations between the mid-course manoeuvre control problem and the minimum error problem on the one hand, and stochastic programs in abstract spaces on the other hand. TAB

N68-19882*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
AN ANNOTATED BIBLIOGRAPHY OF COMPUTER-AIDED CIRCUIT ANALYSIS AND DESIGN
Charles W. Meissner, Jr. Washington 1968 44 p refs
(NASA-SP-7023) CFSTI: HC $3.00/MF $0.65 CSCL 09C

An annotated bibliography is presented on computer aided circuit analysis and design with emphasis on the application of computers to the analysis of electronic circuits. The bibliography presents a listing of authors and their works, and a chronology of the development of computer aided analysis. The bibliography covers the period from 1956 to 1966. B.S.D.

N68-19914 Oklahoma State Univ., Stillwater.
N-PORT MODELING OF LARGE LINEAR NETWORKS
Harold Charles Falk (Ph.D. Thesis) 1966 123 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7218

Algorithms are presented to divide a given large network into subnetworks, to determine the tree and cotree for each subnetwork and to determine for each subnetwork the coefficient matrix S of the fundamental cutset equations. A procedure is given to form the composite of the subnetwork models and obtain the desired n-port model. The algorithms and procedures are implemented into two digital computer programs. Program I computes the n-port model of networks containing passive resistive one-port and multiport devices and ideal drivers. Program II computes the capacitive, and inductive devices and ideal drivers. The algorithms and procedures developed permit a much larger network to be analyzed on a computer of a given size than can be analyzed without network division. The input data required is elementary and n-port models are easily and accurately obtained. Examples are given illustrating the programs and results. Dissert. Abstr.

N68-19930*# University of Southern Calif., Los Angeles. Electronic Sciences Lab.
RESEARCH ON NEW TECHNIQUES FOR THE ANALYSIS OF MANUAL CONTROL SYSTEMS Progress Report, 16 Jun.–15 Dec. 1967
George A. Bekey Jan. 1968 14 p refs
(Grant NGR-05-018-022)
(NASA-CR-93766; USCEE-262; PR-5) CFSTI: HC $3.00/MF $0.65 CSCL 09C

In studying models to describe the adaptive characteristics of the human operator in response to step changes in effective vehicle dynamics, two different sets of failure transitions were explored experimentally. These include three distinct postfailure vehicle dynamics and six different types of possible transition. Four levels of augmentation are considered: rate plus attitude, rate only, attitude only, and none. It is pointed out that since there are many alternative dynamics possible after failure, the operator adaptation algorithm must be of a sequential nature where the structural changes in compensation can be carried to conclusion or terminated in the middle depending upon the postfailure dynamics. Also discussed are the approaches used in treating the problem of identifying unknown sampling frequency when the system and sampling are deterministic and the model is approximate, but the system output is noise corrupted. Modifications to the data acquisition system are reported, along with the adaptation of the IBM 1130 continuous system modeling program to the IBM 360 Model 44. M.G.J.

N68-19959# New York Univ., N. Y. Lab. for Electroscience Research.
SIMULTANEOUS APPROXIMATION IN GAIN AND PHASE OF TWO-PORTS USING LATTICE OF PARALLELED RESONATORS
John F. O'Neil and Mohammad S. Ghausi Oct. 1967 44 p refs
(Contract AF 19(628)-5537)
(AFCRL-67-0562; TR-400-164; SR-8; AD-665134)

The development of networks using only two-pole subcircuits, defined as resonators, permits use of physical systems that are compatible with integrated electronics. Both multiresonator crystal wafers and active RC two port resonators are applicable, and have the potential to greatly reduce the size and cost of frequency selective networks. This paper describes application of an active lattice with paralleled resonators, in the arms to the simultaneous approximation of specified transmission magnitude vs frequency and phase vs frequency characteristics. The approximation is by real frequency interpolation, or exact matching at certain frequencies. Examples indicate that the error between samples is usually tolerable, especially in cases for which the desired characteristics are smooth. Thus, the procedure produces useful networks. Author (TAB)

N68-19972# Illinois Univ., Urbana. Dept. of Computer Science.
MAJOR AND MINOR THRESHOLD FUNCTIONS OF SIX VARIABLES
John A. Rohr (M.S. Thesis) 17 Jun. 1967 31 p refs
(Rept.-234; PB-176859) CFSTI: HC $3.00/MF $0.65

Switching circuits based on the threshold and majority decision principles have recently been used in certain computers. The behavior of these circuits can be represented by a Boolean function whose value is 1 or 0 (corresponding to 'on' and 'off') depending on whether the weighted sum of the variables is or is not greater than a specified value called the threshold. This investigation has

two main objectives: (1) The tabulation of all the representative major and minor threshold functions of six and fewer variables; and (2) The comparison of the corresponding optimum structures obtained by minimizing (a) the threshold, and (b) the total input weight. Author

N68-19995# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
CLOSED-LOOP SENSITIVITY REDUCTION OF LINEAR OPTIMAL CONTROL SYSTEMS
E. Kreindler Mar. 1968 39 p refs Submitted for publication
(Contract AF 33(615)-3411)
(RE-319J)

Inequalities are derived which demonstrate the reduction of sensitivity to plant-parameter deviations of closed-loop linear optimal systems (as compared to nominally equivalent open-loop systems) according to a particular measure of sensitivity. The shortcomings of some other measures of sensitivity are discussed and illustrated in numerical examples. Numerical results for the sensitivity comparison of a first-order system and a third-order pitch-axis control system are given. Author

N68-20067# Air Force Academy, Colo. Frank J. Seiler Research Lab.
AN APPROXIMATION TECHNIQUE FOR SINGULAR CONTROL PROBLEMS
Gerald Cook Dec. 1967 30 p refs
(SRL-68-0003; AD-665151)

A method is presented which permits the solution of singular control problems by approximating the non-normal system with a normal system. It is shown that the approximation can be made arbitrarily accurate. The optimal control of the approximate system is then determined and applied to the actual system. Bounds are obtained on the errors in boundary conditions and the degree of sub-optimality brought about by the technique. The method is valid for minimum time and minimum fuel problems with linear, constant plants. Examples are presented. Author (TAB)

N68-20083# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
INVESTIGATION OF A NETWORK OF NEURON-LIKE DEVICES USED AS A FEEDBACK FORCE-BALANCING POSITION CONTROL ACTUATOR
Richard Carlton Paschall (M.S. Thesis) Jun. 1967 70 p refs
(GGC/EE/67-9; AD-665129)

A feedback control system is constructed by the use of nonlinear neuron-like elements called syncoders in an opposing-actuator control model. A second-order system is simulated on an analog computer and position-controlled with position and force feedback. The syncoder control network is investigated open-loop, and input/output characteristics for the position and force channels are determined. The closed-loop system is examined with the position output of the second-order system being the controlled parameter. The system demonstrates control of position by use of position feedback, of force feedback, or of both feedback signals combined. Author (TAB)

N68-20130# Texas Univ., Austin. Labs. for Electronics and Related Science Research.
DESIGN OF ADAPTIVE CONTROL SYSTEMS THROUGH UTILIZATION OF SENSITIVITY CONCEPTS
Michael K. Masten and B. F. Womack 4 Jan. 1968 133 p refs
(Grants AF-AFOSR-766-67; AF-AFOSR-67-0766A)
(TR-41; AFOSR-68-0005; AD-664912)

The problem of controller design for unidentified time variable systems is considered. The adaptive solution obtained does not identify the unknown plant; rather a low order linear tracker is determined whose behavior is near to that of the plant. The tracker characteristics are sufficiently similar to those of the plant so that controller synthesis based on the information gained from the tracker is assumed adequate for control of the plant. The tracker must be rapidly determined since the plant is time variable; time intervals for which the tracker is not an accurate approximation of the plant represent periods of inferior control. The adaptive rate at which the tracker is determined is considered and a scheme which will provide rapid adaption is developed. Controller design is based upon the approximate plant description provided by the tracker. It is recognized that this description is approximate so the controller is designed in order that overall performance is relatively insensitive to this approximation. Sensitivity theory is employed in the achievement of this objective. Author (TAB)

N68-20145 Columbia Univ., New York.
ANALYSIS OF NONLINEAR IRREGULAR NETWORKS
Se Jeung Oh (Ph.D. Thesis) 1966 144 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-5831

For a broad class of nonlinear networks defined in terms of the element types admitted in the class, a set of classification criteria is established on the basis of the regularity of a given network in the characterization process. Since the criteria require only the knowledge of network topology and element types, the classification procedure provides a convenient operational scheme in the analytical process. A systematic method is developed to modify any irregular networks in the defined class so that they can be characterized in the canonical form by means of augmenting the given network with small parameter network elements. The method requires the minimum number of small parameter network elements for modifying an irregular network. Furthermore, it is demonstrated that an efficient computing scheme can be devised if any irregular network in the defined class is characterized in the canonical form by means of the modification, and the limiting response of the modified network exists. Dissert. Abstr.

N68-20177 Princeton Univ., N. J.
THE IDENTIFICATION OF NONLINEAR SYSTEMS WITH TWO LEVEL INPUTS
George Henry Harris (Ph.D. Thesis) 1966 186 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-5724

Wiener's theory, although of considerable theoretical importance, is shown to be impracticable for present-day computers. However, when the Wiener–Bose theory is applied to nonlinear systems with switched two-level inputs, implementation becomes greatly simplified and tractable on high-speed computers. A convenient method for identifying the class of nonlinear, time-invariant processes with switched two-level inputs and finite memories is successfully applied in this thesis to several nonlinear systems. Of particular interest to chemical engineers is the identification and synthesis of a nonlinear, continuous stirred-tank reactor. This system, as well as others that are investigated, is simulated on a digital computer and identified following an initial observation period. A mathematical model of the process is automatically synthesized by the computer; then the system and model outputs for subsequent two-level input switching are compared. Dissert. Abstr.

N68-20283 Pennsylvania Univ., Philadelphia.
THEORY OF A PARALLEL ACTING AUTOMATON
Serafino Michael Amoroso (Ph.D. Thesis) 1966 208 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-7814

Deterministic automata are defined that abstract the essential features of a chain of finite-state machines operating under the

direction of sequences of instructions from a master control such that at the discrete time steps each machine in the chain is receiving the same instruction as each of the other machines. Each machine is capable of direct communication only with immediately neighboring machines. We consider first a subclass of these automata which are characterized by master control programs consisting of finite sequences of instructions. The next subclass of automata considered are characterized by master control programs that are infinite sequences of instructions each composed of a finite initial sequence of instructions followed by a repeating cycle of instructions. The last subclass of these machines that we consider is characterized by the introduction of a conditional transfer in the master control programs. Dissert. Abstr.

N68-20291*# California Univ., Los Angeles. Dept. of Engineering.
RESEARCHES IN OPTIMAL AND SUBOPTIMAL CONTROL THEORY
Garfield Kang Mar. 1968 93 p refs
(Grant NsG-237-62)
(NASA-CR-93737; Rept.-68-10) CFSTI: HC $3.00/MF $0.65 CSCL 09C

In order to create a structure which allows the relation of the variational methods of Pontryagin and Bellman, the regret function is derived, and the integral representation of regret function for a specific class of control laws is shown. The most direct application of this representation is the rational approximation of known optimal control policies, which is illustrated for linear, time-varying optimal controls. Consideration is also given to the suboptimal control sequences generated by successive approximations, in which monotone approximation techniques are given for both Bellman and Pontryagin conditions. Two apparently new ideas introduced are the iterative method for control functions and the feedback synthesis. A reference bibliography is also included. B.S.D.

N68-20497 California Univ., Los Angeles.
A DESIGN OPTIMIZATION TECHNIQUE EMPLOYING THE CALCULUS OF VARIATIONS
Rex Orin Kidd (Ph.D. Thesis) 1966 136 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-6180

The basic purpose of this dissertation is to develop a new design optimization technique using the calculus of variations. The multiple integral Lagrange formulation of the calculus of variations is used. The formulation utilizes general control systems theory terminology. The technique is more general than present design optimization and cost effectiveness techniques in that it optimizes the design parameters of a military system or commercial product as functions of total program cost, program schedule and other independent variables; in this sense this technique is dynamic. This dynamic technique provides the executive or customer with considerably more information upon which to base major design decisions. It readily permits tradeoffs between effectiveness, cost and schedule to be considered in the decision making process. Dissert. Abstr.

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N68-19511*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PRELIMINARY DESCRIPTION OF THE MODIFIED JPL 25-FT SPACE SIMULATOR
Maurice J. Argoud 1 Feb. 1967 39 p refs
(Contract NAS7-100)
(NASA-CR-93689; JPL-TM-33-319) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A description is presented of a 25-ft space simulator, which is designed for environmental testing of unmanned spacecraft under simulated interplanetary conditions of extreme cold, high vacuum, and intense solar radiation. Author

N68-19551# Brookhaven National Lab., Upton, N. Y.
14-FOOT BUBBLE CHAMBER RESEARCH AND DEVELOPMENT PROGRAM. MECHANICAL DESIGN OF MAGNET COILS
D. A. Kassner Apr. 1967 23 p Presented at the Intern. Colloq., Heidelberg, 13–14 Apr. 1967 Sponsored by AEC
(BNL-11267; CONF-670416-2) CFSTI: HC $3.00/MF $0.65

The mechanical design characteristics of superconducting magnet coils for the 7-ft bubble chamber engineering test facility, which was designed as a one-half scale model of the proposed BNL 14-ft bubble chamber, are discussed. NSA

N68-19559# Princeton–Pennsylvania Accelerator, Princeton, N. J.
CONTROL OF THE BEAM SPILL AT THE PPA
J. Henness, C. L. Kang, J. Kirchgessner, J. Riedel, and F. C. Shoemaker 27 Apr. 1967 13 p Presented at Natl. Particle Accelerator Conf., Washington, D. C., 1–3 Mar. 1967
(Contract AT(30-1)-2137)
(PPAD-620E; CONF-670307-57) CFSTI: HC $3.00/MF $0.65

The PPA machine operates on a 20 cycle per second machine rate and is not flat topped. Due to these two factors spill lengths in the region of 5 to 10 milliseconds are not only long but contain up to 10% energy modulations. Conversely short spills are those occurring in less than a few hundred microseconds. Another unusual feature of the PPA machine is the one to two nanosecond rf bunch width at spill time. This feature was inherent with the first spill techniques and has proven invaluable to experimenters doing time of flight measurements in neutral secondary beams and separating K's from π's. Consequently the preservation of the rf bunching during spill has become a prerequisite for any PPA spill system. Within this boundary condition only the following targeting techniques are feasible: moving targets, magnet steering, rf steering, and resonant blow-up. Each of these techniques is presently utilized by PPA with the first two being secondary controls and the next two being primary controls. Author (NSA)

N68-19650# Library of Congress, Washington, D. C. Aerospace Technology Div.
PLASMA WAVEGUIDES FOR ACCELERATORS
Andrey Polushkin *in its* Foreign Sci. Bull., Vol. 4, No. 3 Mar. 1968 p 1–9 refs (See N68-19649 10-34)

New ideas for particle accelerator designs are briefly described. These include the increase in efficiency of cyclic accelerators by substituting self-stabilizing electron beams for the bulky and costly electromagnets, and the coherent acceleration method in which the accelerating force is produced by the interaction of a geometrically small group of accelerated particles with another group of charges. Emphasis is on Feynberg's work on linear resonant accelerators. These operate with a high frequency field, which excites a traveling or standing wave inside a waveguide. Drift tubes inside the waveguide enclose the particle beam and are spatially arranged so that the gaps synchronize the beam with the accelerating pulse of the electric field component of a traveling or standing wave. The pros and cons of linear accelerators, the use of plasma waveguides to overcome their drawbacks, and developmental problems with the waveguides are discussed. R.N.A.

N68-19865# California Univ., Livermore. Lawrence Radiation Lab.
STATITRON: A LOW ENERGY PULSED ELECTRON ACCELERATOR
D. R. Lasher 14 Mar. 1967 36 p refs
(UCRL-50215) CFSTI: HC $3.00/MF $0.65

The design and operation of the Statitron electron accelerator are described. This accelerator produces 0.5-nsec bursts of 175-keV electrons at a repetition rate of 60 pps. It is used for impulse response tests, as a high-intensity pulsed light source, and for electron transmission and scattering studies at low energies. Author (NSA)

N68-19866 Oklahoma State Univ., Stillwater.
REFINEMENT OF A SINGLE FACILITY ELECTRONIC QUEUEING SIMULATOR AND THE DEVELOPMENT OF AN AUGMENTED QUEUEING SYSTEM SIMULATOR
Charles Louis Burford (Ph.D. Thesis) 1966 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-7199

A queue or waiting line is formed by the collection of individual units of a flow system being temporarily at a restriction in the flow system. This study presents a means of studying such a system by simulation and of demonstrating the characteristics of the system. It discloses the design of an electronic queueing system simulator which can simulate a complex queueing system, which has predetermined parameters. The performance characteristics of the queueing simulator are investigated to determine its adequacy. The simulator was found to be capable of generating random time intervals with controllable parameters and of simulating a queueing system. Dissert. Abstr.

N68-19905# Oak Ridge National Lab., Tenn.
DESIGN CONSIDERATIONS FOR A SEPARATED-TURN ISOCHRONOUS CYCLOTRON (STIC)
M. M. Gordon Dec. 1967 15 p refs
(Contract W-7405-ENG-26)
(ORNL-4175) CFSTI: HC $3.00/MF $0.65

The separated-turn isochronous cyclotron (STIC) under study is a machine that should produce proton currents in the 50- to 100-mA range at energies from 200 to 1000 MeV with clear turn separation so that 100% beam extraction is achieved. Each stage of the cyclotron consists of a ring of identical magnet sectors interspersed with an appropriate set of RF acceleration cavities. The beam is injected from a linac, thereby eliminating the central-region problems associated with present isochronous cyclotrons. As a result of the narrow magnet gaps, the machine has relatively strong axial focusing throughout. The orbital frequency is high enough so that the beam can be accommodated within the space-charge limits. Additional small third-harmonic cavities provide for a flat top on the resultant voltage wave form, thereby allowing a relatively large phase width in the accelerated beam. Conditions for achieving clear turn separation are analyzed and found feasible. For a reasonable total number of turns, the isochronous field trimming requirements are quite tractable. Tentative design figures are presented and compared with the present separated-orbit cyclotron (SOC) designs. Author (NSA)

N68-19938*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 17: ROCKET TESTING AND EVALUATION IN GROUND FACILITIES
John H. Povolny Washington 1968 20 p Presented at Lewis Aerospace Explorers Conf., Cleveland, 1966–1967
(NASA-TM-X-52404) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Large-scale ambient and altitude test facilities at the Lewis Research Center are described in terms of their use in rocket testing and evaluation. Engine and component testing facilities for evaluating the effects of the space environment on upper stage and propulsion system performance are described, as are facilities for determining the structural characteristics and capabilities of complete boosters. Various aspects of structural dynamics are discussed, and reliability and quality assurance efforts are considered in terms of design goals and operations of rockets. M.W.R.

N68-20049 Minnesota Univ., Minneapolis.
TWO-PHASE FLOW THROUGH APERTURES
Pien Chien Chen (Ph.D. Thesis) 1965 171 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-8045

A test facility was designed and constructed for making blowdown tests of saturated water through a variety of apertures with initial pressures up to 250 psig. The objectives of the experiments were to establish criteria for developing predictive methods for the flow of flashing water through apertures. The test results with saturated water indicate no vaporization occurred in the immediate upstream neighborhood of the openings. Saturated water becomes superheated and flows into the apertures as a metastable water jet. Flashing, however, occurs to a certain extent within the apertures causing a backpressure higher than the downstream pressure. Using the pressure differences between the initial pressure and the backpressure in the single-phase orifice equation with the contraction coefficient of 0.61, the mass flow rates can be predicted. For the diverging apertures, the backpressure phenomena are consistent with the theory of free turbulent jets and the analyses on the thrusts created by the flows. Dissert. Abstr.

N68-20133# ARO, Inc., Arnold Air Force Station, Tenn.
PRELIMINARY CONSIDERATIONS IN THE DESIGN OF A LUDWIEG TUBE FOR HIGH REYNOLDS NUMBERS Technical Report, Jul. 1–31, 1967
L. J. Fila (Okla. State Univ.) Arnold Eng. Develop. Center Feb. 1968 25 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-67-210; AD-665115)

Larger aircraft operate at Reynolds numbers above 10 to the 7th power which happens to be the upper limit of experimental information. Designers depend heavily on extrapolating available test results for minimum drag, maximum lift, and boundary-layer phenomena. Estimation of the last item is least reliable and involves the higher risks. There is a real need to extend experimental information to higher Reynolds numbers. Reynolds numbers of 10 to the 8th power are needed now; 4 x 10 to the 8th power can be projected as a need for 1980; and (10 to the 9th power) is a possibility for 2010. If air is used as the wind tunnel fluid, the higher Reynolds numbers can be obtained almost exclusively by high pressures, static and dynamic. This causes the wind tunnel dimensions to be directly proportional to the Reynolds number. Practically, the wall thickness depends essentially on the Reynolds number and the diameter depends on model stresses. If a Ludwieg tube is contemplated, a minimum pressure of about 4 atm simultaneously establishes a maximum tube diameter and a minimum model stress. The length of a Ludwieg tube depends on specified time for a run and attaining uniform flow. Author (TAB)

N68-20139# ARO, Inc., Arnold Air Force Station, Tenn.
OPERATION OF AEDC-VKF 100-IN. HOTSHOT TUNNEL F WITH AIR AS A TEST GAS AND APPLICATION TO SCRAMJET TESTING Technical Report, Jan. 1966–May 1967
I. T. Osgerby and H. K. Smithson Arnold Eng. Develop. Center Dec. 1967 46 p refs Presented at the 5th Hypervelocity Tech. Symp., Denver, Mar. 1967
(Contract AF 40(600)-1200)
(AEDC-TR-67-242; AD-664906)

An experimental and theoretical research program was undertaken to develop the arc-heated hypervelocity Tunnel F for operation as a combustion test facility with air as a test gas. Preliminary results of this test program are reported concerning

gaseous and particle contamination and the limitations on combustion testing attributable to reservoir decay. Author (TAB)

N68-20223 California Inst. of Tech., Pasadena.
THE USE OF A LARGE CONVENTIONAL SHOCK TUBE AS A PRE-IONIZER FOR AN INVERSE PINCH SHOCK TUBE. THE APPLICATION OF THIN-FILM HEAT TRANSFER GAUGES AND FLUSH ELECTROSTATIC PROBES TO PARTIALLY IONIZED FLOWS IN SHOCK TUBES
Alan F. Klein (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-6158

A large diameter, conventional shock tube has been used as the pre-ionizer for an inverse pinch shock tube in an attempt to achieve separation of the shock front and the current sheath in the inverse pinch. The inverse pinch was mounted in the endwall of the shock tube and was operated without an anode, either behind the incident or reflected shock wave generated by the pre-ionizer shock tube. The test gases used were xenon, argon, and helium. Separation was not achieved, but in argon the pressure front did move closer to the front of the current sheath. Previous shock tube observations of spurious signals in the output of thin-film heat gauges at Mach numbers for which the shocked gas becomes partially ionized are summarized. It is shown that these effects, and those observed in the experiments in xenon, cannot be explained in terms of a shorting gauge model. It is demonstrated that the effects are due to the gauge acting more as an electrostatic probe than as a heat gauge. Dissert. Abstr.

N68-20261*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FABRICATION OF THE 23-FT COLLIMATING MIRROR FOR THE JPL 25-FT SPACE SIMULATORS
R. P. Eddy and M. R. Heilig 15 Dec. 1967 27 p refs
(Contract NAS7-100)
(NASA-CR-93792; JPL-TR-32-1214) CFSTI: HC $3.00/MF $0.65
CSCL 14B

The modification of the 25-ft space simulator to produce a larger and higher quality beam evolved a 23-ft-diam, single-piece, spherical, 50-ft focal length mirror. The thermal control restraints, as well as the optical specifications, had a major influence on the final configuration selected. The mirror structure was carefully machined after weld-fabricating. Then the structure was electroplated with nickel, contoured and polished, and, finally, aluminized. The great size of the mirror required the development of several new fabricating techniques. The use of these techniques and recommended modifications should be advantageous in the production of future metal mirrors of this type. Author

N68-20301# Rome Univ. (Italy).
ELDO FUTURE PROGRAMS: FEASIBILITY STUDY OF A S. MARCO TYPE RANGE FOR ELDO VEHICLE LAUNCHES
Mario Marconi and Gennaro Orsi 1964 86 p refs *Its* Study No. 5.3 Prepared for ELDO
CFSTI: HC $3.00/MF $0.65

This note refers to the feasibility of a mobile range designed to meet the basic launching requirements for an ELDO A vehicle and to be capable of erecting and operating in remote marine areas of the world. Because of the mobility of the range facilities, the marine environment of operating, the short time available for setting up the range and the necessary high reliability generally requested to a launching range, a S. Marco type range is proposed considering also the economical point of view. The proposed range essentially comprises a launch area, a main base area, a cryogenic area, a small pyrotechnic area. The range is self-sustaining and includes the mobile capabilities to facilitate transportation for range needs. Emphasis is made on the use of standard proved components, the short preparation time, independence of the ground support equipment from the range and the possibility of interchanging the mobile equipment and of prefabricating the range facilities to achieve low cost. Author (ESRO)

N68-20303# Polish Academy of Sciences. Warsaw. Inst. of Nuclear Research.
THE EXPERIMENTAL AND ANALOG STUDIES OF HEAT FLOW IN THE CATHODE OF A PLASMATRON [ANALOGOWE I MODELOWE BADANIA PRZEPLYWU CIEPLA W KATODZIE PALNIKA PLAZMOWEGO]
A. Strupczewski 1967 43 p refs In POLISH; ENGLISH summary
(INR-855/11A/PP) CFSTI: HC $3.00/MF $0.65

The analog model studies of the cathode of a plasmatron are described. In view of the complicated shape of the inner cooling surface, the heat transfer coefficient distribution was studied experimentally on a model surface. The surface was shaped as a cone intersecting a cylinder, with the cooling fluid changing its direction of flow. The results are given as a dimensionless function for several points on the surface. In the second part of the work, an analog study of heat conduction in the material of cathode was performed with the use of an electrical resistance network. The temperature distributions were found for several shapes of the cathode, taking into account the temperature dependence of heat conduction coefficient of tungsten. The results obtained have made in it possible to significantly increase the power of the plasmatron through a better shaping of the cathode. Author

N68-20403# European Space Vehicle Launcher Development Organization, Paris (France). Engineering Coordination Div.
INTEGRATED CHECKOUT EQUIPMENT FOR THE MULTISTAGE ELDO VEHICLE [EQUIPMENT INTEGRE DE CONTROLE ET DE COMMANDE DE TIR POUR LE VEHICULE MULTIETAGE ELDO]
B. Pottier Feb. 1967 33 p In FRENCH and ENGLISH
(ELDO-TM-E-18) CFSTI: HC $3.00/MF $0.65

This report concerns the overall concept of the proposed integrated checkout equipment for the ELDO multistage vehicle. The principles which have led to this concept are detailed. The functioning of the different components is described and briefly explained. Justification is given for the fundamental design proposals and options chosen. Author (ESRO)

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N68-19524# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.
UNSTEADY FLOW IN TUNNELS
Forbes T. Brown and Rasik P. Shah 30 Sep. 1967 108 p refs
(Contract C-85-65)
(DSR-76107-2; PB-176138) CFSTI: HC $3.00/MF $0.65

Theoretical predictions are made for attenuation, dispersion, and characteristic impedance of long-wavelength small-amplitude waves in turbulent flow in cylindrical lines or tunnels. A lower limit for attenuation and dispersion results from assuming a turbulent viscosity profile across the tube which remains constant throughout the cycle. An upper limit results from assuming a turbulent viscosity profile which fluctuates during the cycle, maintaining the steady-flow values. An experimental apparatus was nearly completed to check the theory and resolve the transition from upper limit to

lower limit. The theory indicates that a relatively simple constant-inertance-resistance model is useful at much higher frequencies than in laminar flow, including most problems of normal vehicle acceleration and deceleration in tunnels, but is totally unacceptable at very high frequencies such as those which result when a vehicle passes rapidly through a sharp or gradual change in the tunnel area. Author

N68-19545# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
NONLINEAR LIFTING SURFACE THEORY FOR ARBITRARY ASPECT RATIO [NELINEINAYA TEORIYA NESUSHCHEI POVERKHNOSTI PROIZVOL'NOVO UDLINENIYA]
A. N. Panchenkov Mar. 1968 18 p refs Transl. into ENGLISH from Russian
(TR-48)

A nonlinear theory for the solution of the flow over low aspect ratio lifting surfaces is developed. Some results are presented for special spanwise distributions of circulation. Author

N68-19575# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.
CONVECTION PROCESSES IN TURBULENT IMPINGING JETS
M. Wolfshtein (Ph.D. Thesis) Nov. 1967 237 p refs
(SF/R/2) CFSTI: HC $3.00/MF $0.65

A finite difference method for the solution of the elliptic equations governing the steady transfer of momentum, heat and matter in turbulent flows is presented. The method ensures that the laws of conservation are satisfied over arbitrarily large or small control volumes. The Kolmogorov–Prandtl hypothesis of turbulence is extended to two dimensional flows and to viscous sublayer near solid walls. The empirical input to the hypothesis is obtained from various sets of data, for experimental situations approximating to Couette flows. Numerical solutions for Couette flows with augmented turbulence were computed and cast in the form of wall functions for use in two dimensional problems. The finite difference method, the viscosity hypothesis, and the wall-functions are then used to obtain solutions for the problem of a plane, turbulent jet impinging normally to a flat surface. Comparisons with experimental results are made, and the influence of the Reynolds and Prandtl numbers is studied. Also studied was the distribution of the kinetic energy of the turbulent velocity fluctuations. Author

N68-19599 Oklahoma State Univ., Stillwater.
THE EFFECT OF CAVITATION ON PARTICULATE CONTAMINATION GENERATION
Robert Elwin Bose (Ph.D. Thesis) 1966 119 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-7192

Cavitation, which can be a major mechanism of contaminant generation in a hydraulic system, was investigated to determine the relationships between the material properties and the particulate material removed as a result of the cavitation. Six ductile materials whose range of mechanical properties encompass those usually found in hydraulic components were tested using an ASME Standard Magnetostriction device. The following conclusions can be drawn from the study: 1. The Brinell hardness number of the material is the best estimator of the largest particle size appearing in the generated particle distributon. 2. The strain energy of the material can be used to determine the particle size distribution generated by cavitation. Empirical relations are presented which define the particle size distribution completely if the strain energy and Brinell hardness of the material are known. Dissert. Abstr.

N68-19630# Sandia Corp., Albuquerque, N. Mex.
AERODYNAMIC BREAKUP OF LIQUID DROPS
R. E. Luna and W. A. Klikoff, Jr. Jun. 1967 45 p refs
(Contract AT(29-1)-789)
(SC-RR-66-2716) CFSTI: HC $3.00/MF $0.65

A survey of the literature on the breakup of liquid drops under aerodynamic loading, vital to the safety assessment of the space application of systems for nuclear auxiliary power, was made. Parameters most appropriate for characterizing the breakup process were determined. The Weber number was found to be the best means for estimating breakup potential of a liquid drop. Weber numbers between 1 and 10 are used for incipient breakup of low-viscosity liquids. Ohnesorge numbers are used to measure the influence of viscosity. For Ohnesorge numbers less than 1, viscous effects are secondary. For numbers greater than 1, the effect of viscosity is to increase the value of the critical Weber number for breakup. NSA

N68-19704*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DYNAMIC PRESSURE OF A VOLUME WITH VARIOUS ORIFICES AND OUTGASSING MATERIALS
John J. Scialdone Nov. 1967 27 p refs
(NASA-TM-X-63133; X-327-67-574) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The dynamic pressure of a spacecraft compartment exposed to a known external pressure profile is investigated. The compartment contains outgassing materials and has known orifice passages. Outgassing materials are: silicone rubber, epon, PTFE, mylar, epoxy, polyurethane, and Silastic. The passages have areas of .01, .1, and 1.0 cm^2. A computer program is used to obtain the internal dynamic pressure. The results have been generalized by grouping in terms of a pumping time constant, the outgassing rate of the material at 1-hour vacuum exposure, and a quasi-steady pressure corresponding to the outgassing rate and the orifice molecular flow rate. Additional plots included here can be used to obtain pressures and times for other systems when the geometry and the behavior of the outgassing material are known. The plots can be used to identify objectionable pressure time conditions in a spacecraft and to indicate ways to avoid them by appropriate adjustment of parameters. The results obtained by the computer program have been compared to those obtained experimentally. Author

N68-19709*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EVALUATION OF BOUNDARY LAYER AND WAKE SURVEY DATA REDUCTION TECHNIQUES IN COMPRESSIBLE FLOWS
K. R. Czarnecki and Russell B. Sorrells, III Washington Apr. 1968 32 p refs
(NASA-TN-D-4401) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The analytical study was limited to turbulent boundary layers with no heat transfer and to a Mach number range from 0 to 10. The experimental portion of the investigation was confined to zero-heat-transfer turbulent-wake surveys made behind a swept wing at free-stream Mach numbers of 1.61 and 2.01. Results of the analytical boundary-layer calculations indicate that if simplified data-reduction techniques that neglect the deviation of the local Mach number from the average free-stream or normalizing value are utilized, sizable differences in momentum, displacement, and velocity thicknesses are incurred over much of the Mach number range for relatively small deviations in the local-flow characteristics or parameters. In general, use of the free-stream Mach number as a base both for determining velocity defects due to skin friction and for normalizing the thickness parameters, will introduce larger differences than use of local Mach number as the base for both items and interpretation of results as being obtained under stream conditions. Experimental wake data indicate that because of increased wake widths and reduced viscous heating or compressibility effects in comparison with boundary layers of equal momentum

deficiency, the use of the free-stream-flow technique generally results in proportionately larger differences in wake-data reduction.
Author

N68-19754 Colorado State Univ., Fort Collins.
CORNER BOUNDARY LAYER
Rodger Birtwell Dowdell (Ph.D. Thesis) 1966 299 p
Available from Univ. Microfilms: HC $13.50/MF $3.85 Order No. 67-5872

The boundary-layer method is applied to a viscous, incompressible fluid flowing steadily along the intersection of two planes. The three-dimensional, boundary-layer equations are derived. A transformation is found which allows the solution, originally obtained by Carrier for a 90° corner, to be extended to corners of any angle. A finite-difference method is used to calculate the velocity distributions, and wall-shear-stress distributions for eleven different angles between 6° and 174°. Calculations were made both with and without functions satisfying the two boundary-layer equations normal to the principle direction of flow. It is found in all cases that these cross-flow terms have a negligible effect on the axial-velocity distribution. Dissert. Abstr.

N68-19764 Connecticut Univ., Storrs.
STABILITY OF PARALLEL VISCOUS FLOWS
Mario Joseph Casarella (Ph.D. Thesis) 1966 144 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-4533

The purpose of this investigation is to review and extend existing techniques for the analysis of the stability of strictly parallel flows to infinitesimal and finite disturbances. A fresh new approach based on the stability theorems of Liapunov is included. New numerical results are obtained for the classical problem of the stability of plane Poiseuille flow to infinitesimal disturbances. The Orr–Sommerfeld equation is solved numerically by a method proposed by Nachtsheim. The eigenfunction solutions to the equation, for both the stable and unstable regions of the α-R plane, are used to compute the streamlines for the disturbed flow, lines of constant vorticity, the Reynolds stress function, and other pertinent quantities. A review of the linear theory of stability is included. Dissert. Abstr.

N68-19765 Colorado State Univ., Fort Collins.
WAKE TURBULENCE FAR DOWNSTREAM FROM AN AXISYMMETRIC BODY
Neddy Huan-Chang Hwang (Ph.D. Thesis) 1966 190 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-5876

Turbulent characteristics in the wake downstream from a flat, circular disk located at the geometric center of a cross section of a recirculating, low-speed wind tunnel were measured principally by a hot-wire anemometer. Three distinct regions of turbulent motion were discernible in the wake: Between the disk and $x \leq 50D$ downstream, the turbulence was highly anisotropic and new turbulence was generated locally; an approximate similarity region was found to exist between $100D \leq x \leq 400D$, where isotropic turbulence relations were adequate for estimating the decay. A region of final period of decay was found in the far wake, $x \geq 400D$. The turbulence in this region is highly intermittent throughout, and the decay rate is lessened. An analytical approach to turbulent motion in its final period based on a superposition of vortex rings was explored and limited success achieved in predicting the measured one-dimensional energy spectra. Dissert. Abstr.

N68-19795*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 8: ZERO GRAVITY EFFECTS
William J. Masica Washington 1968 18 p ref
(NASA-TM-X-52395) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Meanings of zero gravity were examined along with the importance of capillarity and surface energy, the physical tools of energy and the principle of minimum energy, and the behavior of fluids in zero gravity. Space flight in zero gravity is mentioned, and contact angle is one of the boundary conditions discussed. Zero g interface configurations for zero degree contact angle liquids are illustrated for the cases of conical, cylindrical, and spherical tanks; and fluid behavior in baffled tanks is also shown. Details are included for studies related to bond number, the quantity that indicates the relative size of acceleration forces to capillary forces.
M.W.R.

N68-19814 Oklahoma State Univ., Stillwater.
A NUMERICAL SOLUTION FOR THE INTERACTION OF A MOVING SHOCK WAVE WITH A TURBULENT MIXING REGION
William Fred Walker (Ph.D. Thesis) 1966 209 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-7309

The primary objective of this study was to provide a method whereby the phenomenon associated with the interaction between a moving shock wave and a turbulent mixing region could be investigated. In order to accomplish this objective, it proved necessary to write the complete mathematical description of the two-dimensional turbulent mixing process. The turbulent exchange coefficients were approximated with the aid of the Prandtl–Gortler theory for free turbulence. Rusanov's finite difference method, which utilizes the principle of artificial viscosity, was adapted to the requirements of the investigation. A detailed stability analysis was performed and the resulting stability criteria for the difference equations was given. A problem which considered a plane Mach 2 jet issuing into a cavity was postulated; and the transient field computed until a steady state turbulent mixing region was established. Moving shock waves of two different strengths were then introduced into the field and the shock wave-mixing region interaction studied. Dissert. Abstr.

N68-19865 Oklahoma State Univ., Stillwater.
THE MEAN VELOCITY DISTRIBUTION IN FULLY DEVELOPED TURBULENT WATER FLOW IN A STRAIGHT CIRCULAR PIPE
Donald Frank Haber (Ph.D. Thesis) 1966 82 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-7225

Three series of tests were run measuring the mean velocity distribution of fully developed turbulent water flow at the outlet cross-section of a straight plexiglass pipe 76 mm in diameter and 23.6 m long using a hot-film probe and constant temp anemometer. In the first series of tests, the probe tip was located at various distances outside the outlet cross-section. In this region adjacent to the wall, the velocities measured were substantially higher than predicted by the viscous sub-layer hypothesis and were not independent of the Reynold's number. The second series of tests were conducted with the hot-film probe tip located 3 mm inside the pipe outlet cross-section. The velocities measured in this region were much lower than the viscous sublayer theory predicts. The third series of tests were carried out with the hot-film probe tip to be positioned behind the pipe wall. The results of the tests gave a confirmation of the "Law of the Wall" and the "Law of the Wake" for the complete pipe cross-section. Dissert. Abstr.

N68-19874 Lehigh Univ., Bethlehem, Pa.
AN INVESTIGATION OF THE FLUID RESISTANCE TO DIALYSIS MASS TRANSFER IN A TUBULAR MEMBRANE
Nicholas Comninos Kafes (Ph.D. Thesis) 1966 201 p
Available from Univ. Microfilms: HC $9.25/MF $3.00 Order No. 67-4869

An experimental system has been developed for a study of the dialysis mass transfer operation. A cellulose dialysis membrane in tubular form was suspended in a column and the effect of flow conditions on the mass transfer coefficient was determined by passing water through the tubular membrane counter-current to a circulating brine solution in the annulus. The suitability of this apparatus for obtaining data which can be utilized in the study of the laminar and turbulent mass transport mechanism is demonstrated. Theories of mass transfer in fluids, which have evolved primarily by analogy to the heat transfer operation and from data acquired in wetter wall columns and from pipe dissolution studies, can now be compared with data collected from an apparatus which has certain advantages over these two mass transfer systems. Dissert. Abstr.

N68-19916# National Physical Lab., Teddington (England). Aerodynamics Div.

NOTE ON CONDITIONS NEAR A SEPARATION LINE IN TWO-DIMENSIONAL TURBULENT FLOW

P. Bradshaw 2 May 1967 14 p refs Prepared for Min. of Technol.

(NPL-AERO-1232; ARC-29053) CFSTI: HC $3.00/MF $0.65

It is shown that the effects on the turbulence structure of the streamline divergence and curvature which result from rapid boundary-layer growth may be more important than the second-order terms in the mean-motion equations. Because of the approximately hyperbolic nature of turbulent momentum transfer, the flow in the inner layer up to separation can be calculated with only small allowances for these extra effects if the pressure distribution on the surface is known. Author (ESRO)

N68-19974 Oklahoma State Univ., Stillwater.

THE DYNAMICS OF VISCOUS FLUID TRANSMISSION LINES WITH PARTICULAR EMPHASIS ON HIGHER MODE PROPAGATION

Charles Richard Gerlach (Ph.D. Thesis) 1966 166 p

Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-7222

The dynamics of viscous fluid transmission lines have been investigated with emphasis being placed upon topics of interest in both fluid systems engineering and acoustic fields. An exact solution of the first-order Navier–Stokes equation was obtained to describe the dynamics of a viscous, compressible liquid in closed conduits. This solution demonstrated the existence of an infinite set of viscous modes of propagation. Calculations were made of the spatial attenuation factor and phase velocity for several modes for both rigid and elastic flexible conduit walls. Also calculated were the velocity profiles near an oscillating piston and subsequently the state of shear stress near the piston. Engineering models, based upon approximations of the zeroth mode, were developed and experimental studies were made of the frequency response and transient response of a viscous fluid transmission line.

Dissert. Abstr.

N68-19987# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.

INFLUENCE OF MASS TRANSFER ON SURFACE FRICTION AT A POROUS SURFACE

E. Baker Jan. 1967 221 p refs

(TWF/R/3)

An investigation was conducted on the influence of mass injection, through smooth and rough surfaces, on the development of turbulent boundary layers and wall jets. Experiments were conducted which demonstrated that the size of the pores on a porous surface can have a large influence on the development of a transpired turbulent boundary layer. A calculation procedure was presented which successfully predicted the flow development under these conditions. It was found that the local effective wall shear in a transpired radial wall jet was a function of both the injection rate and the size of the pores. Spalding's calculation procedure was extended to include mass transfer through smooth and rough surfaces. The results of the transpired-radial-wall-jet experiment were used to determine the appropriate forms for the auxiliary relations used in the calculation procedure. Author

N68-20091# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany). Institut fuer Luftstrahlantriebe.

EXPERIMENTAL INVESTIGATIONS AND BOUNDARY LAYER THEORETICAL CALCULATIONS ON DECELERATING CASCADES AT COMPRESSIBLE FLOW, ESPECIALLY WHEN CHANGING THE RATIO OF AXIAL MASS FLOW DENSITY AND THE UPSTREAM INTENSITY OF TURBULENCE [EXPERIMENTELLE UND GRENZSCHICHTTHEORETISCHE UNTERSUCHUNGEN AN EBENEN VERZOEGERUNGSGITTERN BEI KOMPRESSIBLER STROEMUNG, INSBESONDERE BEI AENDERUNG DES AXIALEN STROMDICHTEVERHAELTNISSES UND DER ZUSTROEMTURBULENZ]

W. Heilmann Dec. 1967 153 p refs In GERMAN; ENGLISH summary

(DLR-FB-67-88; DVL-664) CFSTI: HC $3.00/MF $0.65

The structure of the cascade tunnel on which the investigations were performed and its measuring and control system are described. By means of selected cascade measurements it is proven that the ratio between the axial mass-flow density upstream and that downstream changes the behavior of the blade boundary layer and consequently the cascade performance. To prove the experimental results, theoretical calculations on laminar and turbulent boundary layers are shown. The total pressure loss is determined out of the boundary layer values on the trailing edge of the blades. Theoretical and experimental results are compared. Author

N68-20134# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.

A SURVEY OF HIGHER-ORDER BOUNDARY-LAYER THEORY

Milton van Dyke Sep. 1967 30 p refs Presented at AGARD Seminar on Numerical Methods for Viscous Flows, Teddington, England, 18–21 Sep. 1967

(Contract AF 49(638)-1274)

(SUDAAR-326; AFOSR-67-2291; AD-665136)

A survey of higher-order boundary-layer theory was made. The solutions to a number of cases of steady, plane or axisymmetry, laminar flows are reviewed where one or more of the higher order effects such as, displacement, longitudinal curvature, transverse curvature, and external vorticity are considered. The method of matched asymptotic expansion is offered as a technique which can be applied to such problems without having to rely upon physical insight. The more complicated compressible second-order boundary theory in contrast with the incompressible case is seen developed with minimum of error. A new field of application for higher-order boundary-layer theory is discussed. This is motion in which the basic inviscid flow is singular at the surface of the body. This situation has arisen recently in various branches of high-speed aerodynamics. Author (TAB)

N68-20200# Minnesota Univ., Minneapolis.

HYDRODYNAMIC STABILITY OF DEVELOPING FLOW IN A PARALLEL-PLATE CHANNEL

Te-Shen Chen (Ph.D. Thesis) 1966 289 p

Available from Univ. Microfilms: HC $13.05/MF $3.75 Order No. 67-7710

An investigation is made of the hydrodynamic stability of an incompressible, laminar flow in the development region and the fully developed region of a parallel plate channel. The analysis is based on the theory of small disturbances. A wide variety of analytical and numerical methods are employed to solve the Orr–Sommerfeld equation. The analytical methods are built on asymptotic stability theory. It is found that: (1) the critical Reynolds number decreases monotonically with increasing distance from the

channel entrance to a constant value for the fully developed flow: (2) the boundary layer model, in general, predicts higher critical Reynolds numbers than the full channel model; (3) both the full channel and the boundary layer models predict essentially identical critical Reynolds numbers in the region very near entrance of the channel; (4) the boundary layer model is not a valid approach for investigating stability in the region away from the entrance of the channel; and (5) the approximate formulae of Lin fail to give accurate critical Reynolds numbers in the development region, except very close to the fully-developed flow. Dissert. Abstr.

N68-20206# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.

ON THE PRECIPITATION OF SMALL PARTICLES FROM A VISCOUS FLUID BY AN ELECTRIC FIELD

F. Edward Ehlers Oct. 1967 16 p ref *Its* Math. Note No. 535 (D1-82-0661; AD-664920)

To study the possibility of using an electric field to precipitate small unfilterable particles from a viscous oil, the trajectory equations are integrated for the path of a charged spherical particle in Poiseuille flow between two parallel charged plates. The radius of the particle is assumed to be so small and the flow velocity so slow that the drag on the sphere is given by Stokes formula. The dimensionless length parameter for capture of the particle by one of the plates for a particle having an initial velocity equal to the fluid and starting at a given point in the channel is obtained as a function of a single dimensionless parameter. Graphs of the dimensionless distance parameter for capture of the particle are presented for several starting positions between the plates of the channel. Author (TAB)

N68-20255 Ohio State Univ., Columbus.

KNUDSEN AND TRANSITION DIFFUSION OF GASES IN POROUS SOLIDS OVER A THOUSANDFOLD PRESSURE RANGE

Ralph Sanford Cunningham (Ph.D. Thesis) 1966 314 p
Available from Univ. Microfilms: HC $14.20/MF $4.05 Order No. 67-6305

A study of the Knudsen and transition regions of diffusion in porous solids was made with emphasis placed upon the change from Knudsen diffusion to transition diffusion. The experimental technique employed was one which allows the faces of a cylindrical porous solid to be exposed to different gases while the sides of the solid are sealed so that diffusion occurs along the cylindrical axis only. A nitrogen–helium system was studied, and the counter-diffusion fluxes were measured as a function of the system pressure. The entire system was at constant total pressure so that the transport mechanism was one of diffusion due to an existing concentration gradient. With the apparatus used, the pressures studied could be varied over a 1300/1 range, from 0.5 mm Hg to 600 mm Hg, thus enabling the Knudsen and transition regions of diffusion to be investigated. Dissert. Abstr.

N68-20257 Pennsylvania State Univ., University Park.

LARGE EDDY STRUCTURE OF A TURBULENT WAKE

Fred Ray Payne (Ph.D. Thesis) 1966 175 p refs
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-5951

The objective is to apply Lumley's decomposition theorems to empirical data as a decisive test of the validity of his theory for predicting the large eddy structure of turbulent flows. Grant's data for the turbulent wake of a cylinder are selected for their relative completeness. The conclusion drawn is that Lumley's objective definition of large eddy does correspond to the intuitive ideas of workers in turbulence. More detailed information on the structure and dynamics of these eddies will require more extensive measurements of greater accuracy. Dissert. Abstr.

N68-20281# Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.

CLASSICAL THEORY FOR THE INTERACTION OF GAS ATOMS WITH SOLID SURFACES

Roderick M. Logan and James C. Keck Oct. 1967 81 p refs (Contract Nonr-1841(93))
(Publ.-67-8; AD-664679)

A classical theory for the interaction of gas atoms with solid surfaces is presented. The principal assumptions of the model used are: (1) The surface atoms involved in the collisions can be represented as independent one-dimensional oscillators; (2) the gas atoms interact with the surface through a stationary square-well attractive potential and an exponential repulsive potential; (3) the surface is flat so that the tangential velocity component of the gas atom is unchanged; (4) the surface oscillators have an equilibrium energy distribution at the temperature of the solid. This model represents a logical successor to the hard-cube model introduced by Logan and Stickney (J. Chem. Phys. 44, 195 (1966)) and allows the important effects involving the collision time and the natural frequency of the surface atoms to be taken into account. Author (TAB)

N68-20351# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.

SOLUTION OF THE BOLTZMANN EQUATION FOR A SHOCK WAVE

Akira Sakurai (Waterways Expt. Sta.) Jun. 1967 24 p refs (PIBAL-1027; PB-177148) CFSTI: HC $3.00/MF $0.65

The molecular velocity distribution function f for the shock structure of a neutral gas is studied by pursuing a direct solution of the Boltzmann equation; this approach is in contrast to the kinetic theory procedure of seeking solutions to the Boltzmann moment equations. It is shown that the solution with the Mott–Smith type expression can be constructed to satisfy the Boltzmann equation L (f) = 0 in the sense of L (f) = 0 (M) to the $-n$ power) for a finite, fixed molecular velocity, with M denoting Mach number and n denoting a positive integer. Author

N68-20352*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF GRAVITY ON A FORCED CIRCULATION PATTERN IN SPHERICAL TANKS

Steven G. Berenyi, Ralph C. Nussle, and Kaleel L. Abdalla Washington Apr. 1968 25 p refs
(NASA-TN-D-4409) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An experimental investigation of the effect of gravity on a forced circulation pattern in spherical tanks was conducted. The tank systems tested were exposed to acceleration levels of approximately 0.005, 0.01, 0.02, 1.0, and less than 10^{-5} g. The flow pattern of an axisymmetric wall jet was experimentally established in three different size tanks. The results indicate that the minimum jet inlet velocity required to establish and maintain the flow pattern is a function of jet inlet thickness, tank radius, and gravity level. Author

N68-20388# Laboratoire de Recherches Balistiques et Aerodynamiques, Vernon (France).

MATHEMATICAL MODEL FOR SIMULATING LIQUID SLOSHING IN A TANK [MODELE MATHEMATIQUE POUR LA REPRESENTATION DU BALLOTTEMENT DES LIQUIDES DANS UN RESERVOIR DE FORME QUELCONQUE]

M. Boudet 15 Jan. 1968 77 p refs In FRENCH
(NT-6/68/EN) CFSTI: HC $3.00/MF $0.65

This note demonstrates the existence, for a tank of any form, of a pendulous scheme able to simulate the sloshing effect. It is assumed that amplitudes are such that the equations can be linearized and that the tank is only submitted to translation and

rotational motions the corresponding vectors being either perpendicular or parallel to the free surface of the liquid at rest. Author (ESRO)

N68-20398# National Physical Lab., Teddington (England). Aerodynamics Div.
SPURIOUS PRESSURE FLUCTUATIONS IN WIND TUNNELS
J. A. B. Wills 6 Jul. 1967 14 p refs
(NPL-AERO-1237; ARC-29265) CFSTI: HC $3.00/MF $0.65

Wall pressure spectra measured in wind tunnels usually exhibit a pronounced rise at low frequencies, in conflict with theoretical predictions and those experiments carried out without the constraint imposed by the wind tunnel. Some wind-tunnel experiments are described to show that typically the spurious disturbances arise in the first diffuser and travel upstream as acoustic waves. Removal of the diffuser produces a spectrum falling at low frequencies. Author (ESRO)

N68-20405*# Harvard Coll. Observatory, Cambridge, Mass.
FE I, CR I AND CR 2 GF-VALUES FROM SHOCK-TUBE MEASUREMENTS
M. Huber and F. L. Tobey, Jr. Paris ESRO Dec. 1967 51 p refs
(Grant NsG-438)
(NASA-CR-93856; ESRO-SN-12) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Measurements of f-values by the absorption technique from a shock-heated gas are described. The line emission from the hot gas had made it necessary to apply corrections to the observed equivalent widths. Considerable line widths which are due almost exclusively to Van der Waals broadening have been observed. A correction for the resulting line wing absorption has been incorporated into the data reductions. The results show disagreements with ϕ-values of Corliss et al. (arc measurements) on the absolute scale and with lines which have an upper excitation potential exceeding 48 000 cm^{-1} on the relative scale. The latter discrepancy is attributed to a partially erroneous normalization function used in the previous measurements on an open arc. ESRO

N68-20469# Johns Hopkins Univ., Baltimore, Md. Dept. of Mechanics.
THE MOTION DUE TO A CYLINDER ROTATING IN A STRATIFIED FLUID
Barry M. Yaffe Jan. 1968 122 p refs
(Contract Nonr-4010(01); Grant E-22-50-68(G))
(TR-24; TR-27; AD-665312)

The steady motions set up by a cylinder rotating in a linearly stratified fluid are investigated both theoretically and experimentally. It is observed that the bulk of the flow is horizontal, characterized by a system of jets located at the level of the cylinder and extending out laterally for large distances. Directly adjacent to either of the cylinder flanks, however, the flow is oriented vertically in a relatively thin boundary layer. Separate visco-diffusive theories for the horizontal far-field flow and the vertical near-field flow are developed. By an integral analysis of the entire flow field it is shown that the far-field flow depends on the details of the near-field flow only through a parametric constant representing the difference between the applied viscous torque and the total buoyancy countertorque which opposes this applied torque. TAB

N68-20516# National Physical Lab., Teddington (England). Aerodynamics Div.
A CALCULATION METHOD FOR THE INCOMPRESSIBLE TURBULENT BOUNDARY LAYER, INCLUDING THE EFFECT OF UPSTREAM HISTORY ON THE TURBULENT SHEAR STRESS
J. F. Nash and A. G. J. Macdonald 11 May 1967 69 p refs
(NPL-AERO-1234; ARC-29088) CFSTI: HC $3.00/MF $0.65

An integral method is described for calculating the development of the incompressible turbulent boundary layer in two dimensions. The method is based on a first-order differential equation for the integral of the shear stress across the boundary layer. This equation takes account of the dependence of the shear stress on the upstream history, allowing it to lag behind the value corresponding to an equilibrium boundary layer with the same mean velocity profile. The degree of lag is chosen to give the best overall agreement with fourteen measuring boundary layers covering a range of types of pressure distribution. Author (ESRO)

N68-20517# Minnesota Univ., Minneapolis.
THE TRANSPORT PROPERTIES OF POLYATOMIC FLUIDS
Stanley Irving Sandler (Ph.D. Thesis) 1966 190 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-7778

This thesis is a theoretical study of transport phenomena in polyatomic fluids. In particular, the phenomenological transport coefficients of several models of rotating molecules are calculated by the application of the Chapman–Enskog method to the appropriate Boltzmann equation (for dilute gases) or Enskog equation (for dense gases). Studies are made of dynamical anisotropies upon the calculated values of the usual transport coefficients (i.e., the bulk and shear viscosity and the thermal conductivity) and the rate of convergence of the Enskog series. A detailed account of the dilute gas transport properties of the loaded sphere model is given. The transport properties of a dilute gas of spherocylinders are also considered in chapter 2. The method of solution of Chapman and Enskog is extended to treat kinetic equations for dense polyatomic gases. A dense gas of loaded spheres is also considered. Dissert. Abstr.

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N68-19512# Environmental Research Corp., Alexandria, Va.
SIGNAL ANALYSIS USING AUTO AND CROSS CORRELATION TECHNIQUES AND ASSOCIATED PROCESSES. A STATISTICAL APPROACH TO SEISMOGRAM ANALYSIS Final Report
R. L. Gorman [1967] 55 p refs
(Contract AT(29-2)-1163)
(NVO-1163-86) CFSTI: HC $3.00/MF $0.65

The Fourier amplitude spectrum of a seismogram tends to have a somewhat erratic fine structure which can be smoothed, thereby facilitating its examination, by statistical techniques. The object of the study is to demonstrate the significance and optimization of window-smoothed Fourier amplitude-squared spectra (i.e., power spectra). This preliminary report condenses, unifies and extends those mathematical foundations of signal processing smoothing techniques, given in the references, which are pertinent to the prediction problem. The theory has been developed for stationary processes, though actual seismograms in practive are not stationary. However, the successful use of this theory, as for example in the nuclear detection problem (also a non-stationary process), suggests that it be investigated for applicability to the prediction problem. Also, the mathematics are presented from an abstract, operational point of view enabling a clarification of the

statistical concepts with an indication of the usefulness of the stationary theory, even in the non-stationary case; e.g., the stability calculated for a given processing assuming stationary records will probably to less than the actual stability if this processing is used on non-stationary seismograms. The effects of smoothing of actual data are being studied, including the effects of variation in window shapes, window sizes and sample sizes. The theory has been extended to enable a direct processing of unsmoothed Fourier amplitude spectra and also to enable various coherence studies to be made in order to determine how closely different records relate to each other. Author (NSA)

N68-19517# Washington Univ., Seattle. Dept. of Atmospheric Sciences.
PROFILES OF WIND SPEED, TEMPERATURE AND HUMIDITY OVER THE SEA Scientific Report
Clayton A. Paulson Oct. 1967 139 p refs
(Grant NSF GP-2418)
(PB-176287) CFSTI: HC $3.00/MF $0.65

One hundred eighteen sets of simultaneous profiles of wind speed, temperature and humidity are obtained from data collected over the Indian Ocean. Measurements were made at heights 1 to 8 m above the sea by use of instrumentation mounted on a buoy designed especially for the purpose. The effects on the profile measurements of the motions of the buoy are analyzed and concluded to be negligible, at least insofar as they relate to the computation of turbulent fluxes. The sampling error of the profile measurement system is examined and a correction procedure is devised. The over-all ramdom errors in the measurements after correction for sampling error are estimated to be 3 cm/sec in the wind, .009 deg C in the temperature and .03 gm/kg in the specific humidity. Author

N68-19546# Naval Research Lab., Washington, D. C.
REPORT OF NRL PROGRESS
Oct. 1967 54 p
(PB-176290) CFSTI: HC $3.00/MF $0.65

Contents: On the electromagnetic momentum of convection currents; Components of a new shock measurement system. Author

N68-19553# Environmental Research Corp., Alexandria, Va.
RAY THEORY SEISMIC PULSE (RATS PULSE)
Virginia W. Whitley 30 Mar. 1967 38 p refs
(Contract AT(29-2)-1163)
(NVO-1163-105) CFSTI: HC $3.00/MF $0.65

An operational Fortran IV program, titled RATS, for use on a CDC 3600 system, is described. The program allows computation of the radial and vertical displacement time functions for the problem of propagation of a compressional pulse in a solid half-space overlain by a solid layer. Author (NSA)

N68-19571*# Aztec School of Languages, Inc., Acton, Mass.
TRANSACTIONS OF THE CENTRAL AEROLOGICAL OBSERVATORY, VOLUME 52. RESULTS OF ROCKET INVESTIGATIONS OF THE ATMOSPHERE DURING THE INTERNATIONAL GEOPHYSICAL YEAR AND THE INTERNATIONAL GEOPHYSICAL COOPERATION
I. A. Khvostikov, ed. Washington NASA Mar. 1968 48 p refs Transl. into ENGLISH of the book "Trudy Tsentral'noy Aerologicheskoy Observatori, Vyp. 52. Resul'taty Raketnikh Issledovaniy Atmosphery v Period Mgg i Mgs" Moscow, Hydromet. Press, 1964 p 1–50
(Contract NASw-1692)
(NASA-TT-F-11422) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Data are tabulated for atmospheric rocket soundings conducted in the USSR during the IGY and IGC, and a series of articles based on these data are included. Stratospheric temperature profiles, vertical stratification, and anomalous heating of the Arctic stratosphere are analyzed. Detailed techniques for measuring and interpreting atmospheric meteorological parameters are given. E.J.S.

N68-19580# Coast and Geodetic Survey, Washington, D. C.
STATE PLANE COORDINATES BY AUTOMATIC DATA PROCESSING
Charles N. Claire GPO 1968 72 p refs
(Publ.-62-4) GPO: HC $0.45; CFSTI: MF $0.65

The tables and formulas for computing state plane coordinates by electronic data processing equipment are given, and an explanation of the constants and their derivations is presented. The tables contain the factors most difficult to compute, namely the radii of the parallels for the Lambert projection and values of y on the central meridian for the parallels on the transverse Mercator projection. Equations are given for Lambert projection, transverse Mercator projection, Alaska projection, Samoa projection, Guam projection, and the Puerto Rico, Virgin Islands, and St. Croix projections. State coordinates which were originally computed from geographic positions rounded to three decimal places in seconds, are rectified by rounding the positions to four, or even five, decimal places in seconds. This permits much greater precision in azimuth and length determination by inverse computation using either geographic positions or plane coordinates. B.S.D.

N68-19616 Washington, Univ., Seattle.
TRANSIENT WAVE PROPAGATION IN DISPERSIVE OR CONDUCTING MEDIA
Boppana Lakshmi Jaganmohan Rao (Ph.D. Thesis) 1966 138 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-7669

Transient wave propagation in conducting medium is important in geophysical prospecting, in considering the transient skin effect and in underground or underwater communication. The pulsed carrier propagation in plasma is important in Radar communication systems. This report considers these two problems. Approximate solutions are obtained for the transient fields when a plane wave of step modulated sinusoid propagates in infinite and semi-infinite conducting medium. Modified saddle point method is used to obtain a solution which is valid for large time. Asymptotic series expansion method is used to obtain a solution which is valid for small time. It is found that the solution obtained by saddle point method is satisfactory even for small times. The transient fields, due to a dipole placed in lossless plasma and excited by a delta function, step function and step modulated sine wave are obtained in closed form. Dissert. Abstr.

N68-19631# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
MIDLATITUDE AURORAL SPECTRA
K. C. Clark (Washington Univ., Seattle) and R. J. Hoch 29 Jun. 1967 25 p refs Presented at the Conjugate Point Symp., Boulder, Colo.
(Contract AT(45-1)-1830; Grant NSF GP-3914)
(BNWL-SA-1292; CONF-670631-1) CFSTI: HC $3.00/MF $0.65

At Richland, Washington, (L = 2.7) routine patrol spectrograms of auroras in the magnetic meridian, resolving wavelength and elevation angle, were obtained for the 1966–1967 season. With sensitivity adequate for airglow lines, records show sequences of moderately strong auroral spectra on ten nights of high magnetic activity. These displays usually continued over several hours. In each case the region of greatest intensity seemed well to the north, but the emission sometimes extended to the magnetic zenith with diminished intensity. Characteristically, the spectra show increased red/green intensity ratios of the oxygen lines 6300/5577A typical of type A red auroras, and in the most intense cases the hydrogen

Hα and Hβ lines are evident. Inversion of the relative intensity of the 4709A (0,2) and 4652A (1,3) first negative nitrogen bands is noted in a case where the nitrogen intensity and oxygen red enhancement are high. Some increase in auroral activity with the solar cycle is suggested by the spectral character and frequency of these displays. Author (NSA)

N68-19662# Arizona Univ., Tucson. Inst. of Atmospheric Physics.
SILVER IODIDE SEEDING AND RADAR ECHOES FROM CONVECTIVE CLOUDS
Louis J. Batten 15 Oct. 1967 14 p refs
(Grant NSF GA-310)
(SR-23; PB-176956) CFSTI: HC $3.00/MF $0.65

Summer convective clouds over a fairly isolated mountain range over southeastern Arizona were seeded by means of airborne silver iodide generators. The selection of days to be seeded was made according to a randomization scheme involving pairs of days. A 3-cm vertically scanning radar set was used to observe the maximum echo height over the 'target' area at 30 minute intervals. The data so obtained were used to examine the effects of the seeding on the vertical extent of the cloud echoes. Although there is a suggestion that the silver iodide nuclei may have initiated precipitation in some clouds and caused small vertical echo growths, the statistical analyses, for the most part, showed that the observed differences could easily have been caused by chance. Author

N68-19690 Ohio State Univ., Columbus.
EARTH GRAVITY MODELS BASED ON DISTINCT 5° BY 5° VALUES OF TOPOGRAPHY AND MOHO
Dan Sharni (Ph.D. Thesis) 1966 236 p
Available from Univ. Microfilms: HC $10.80/MF $3.05 Order No. 67-6368

The problem of predicting gravity anomalies is presented and earth-gravity models, whose anomaly fields could closely approximate the free-air anomaly field are introduced. These models are based on distinct 5°×5° mean values of the elevation and the crustal thickness of the earth. Mean crustal thickness values were estimated for all 5°×5° surface elements. A study of the elevations and the crustal thicknesses, together with comparisons to an Airy–Heiskanen model and mass-balance considerations, yielded a mass-model for the earth. Author

N68-19734 State Univ. of Iowa, Iowa City.
VLF RAY TRACING IN A MODEL IONOSPHERE
Stanley Dean Shawhan (Ph.D. Thesis) 1966 186 p
(Contract Nonr-1509(06))
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-2675

A VLF ray tracing study in a model ionosphere including ions is presented. A review of previous VLF ray tracing methods is given. The physical meaning of rays and ray paths is discussed and it is concluded that for ray tracing in the ionosphere the wave packet and Poynting vector approaches give the same results. Two-dimensional ray tracing equations are derived for the case of a horizontally stratified ionosphere and the derivation of three dimensional equations for the curved ionosphere is sketched. These ray tracing equations are integrated for the special cases of exactly transverse and exactly longitudinal propagation but it is concluded that neither case can persist for very-low-frequency radio waves in the ionosphere. Also the conditions for reversibility of a ray path are derived. It is found that the computer program for numerical integration of the ray tracing equations can retrace a path to 0.3% in latitude and 0.02% in wave normal angle and can reproduce known results for the horizontally stratified model. Dissert. Abstr.

N68-19760# Royal Aircraft Establishment, Farnborough (England).
VARIATIONS IN EXOSPHERIC DENSITY AT HEIGHTS NEAR 1100 KM, DERIVED FROM SATELLITE ORBITS
G. E. Cook and Diana W. Scott Aug. 1967 45 p refs
(RAE-TR-67180; AD-665112)

In an earlier paper, values of exospheric density were obtained from the orbit of Echo 2 for the years 1964-65. The results indicated a semi-annual variation in density by a factor of between 2 and 3, considerably larger than predicted by existing atmospheric models. These studies have now been extended to the beginning of 1967, using both Echo 2 and Calsphere 1, to show how the density is responding to increasing solar activity. Variations in density during 1964 have been analysed in more detail. The long-term variation associated with the solar cycle and the short-term variations associated with magnetic and solar disturbances agree with the variations expected on the basis of current models. The semi-annual variation is persisting to higher levels of solar activity, and, although its amplitude is diminishing, the factor of variation was still 1.6 in 1966. Author (TAB)

N68-19786*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
RING CURRENT PARTICLE DISTRIBUTIONS DERIVED FROM RING CURRENT MAGNETIC FIELD MEASUREMENTS
R. A. Hoffman and L. J. Cahill, Jr. (New Hampshire Univ.) Feb. 1968 42 p refs Prepared in cooperation with New Hampshire Univ.
(Grant NsG-624)
(NASA-TM-X-63147; X-611-68-92) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The particle energy density distribution for the symmetric portion of the April 17, 1965, magnetic storm has been deduced from the measured ring current magnetic field profile. This distribution contains a basic spatial distribution and a time decay term which is a function of distance in order to accomplish the fit between the calculated magnetic effects of the particles and the measured ring current field over a period of a day. With various assumptions as to the particle loss, the time decay yields the average energy of the particles as a function of distance, and thence the total integral omnidirectional proton flux. Author

N68-19819*# Bureau of Mines, Minneapolis, Minn. Research Center.
MULTIDISCIPLINARY RESEARCH LEADING TO UTILIZATION OF EXTRATERRESTRIAL RESOURCES Quarterly Status Report, 1 Oct. 1967–1 Jan. 1968
Walter E. Lewis 1 Jan. 1968 38 p refs
(NASA Order R-09-040-001)
(NASA-CR-93726) CFSTI: HC $3.00/MF $0.65 CSCL 08I

The objectives are defined, and summary data on progress are presented for a variety of research projects. These pertain to developing an extraterrestrial mineral resource extraction, processing, and utilization technology for supporting manned lunar and planetary missions; selection, sample collection, and physical properties of simulated lunar materials; chemical reactivity and cold welding of freshly formed surfaces; surface and thermophysical properties of rock; feasibility of thermal fragmentation studies in vacuum; drilling problems; effect of lunar environment on the behavior of fine particles; support for underground lunar shelter; use of explosives on the moon; volcanism and ore genesis as related to lunar mining; reduction of silicates with carbon; magnetic and electrostatic properties of minerals in a vacuum; biological production of sulfuric acid; electrowinning of oxygen from silicate rocks; and stability of hydrous silicates and oxides in lunar environment. M.G.J.

N68-19827# Massachusetts Univ., Amherst. Geology Dept.
PAST VERSUS PRESENT WIND ACTION IN THE MOJAVE DESERT REGION, CALIFORNIA
H. T. U. Smith Dec. 1967 39 p refs
(Contract AF 19(628)-2486)
(SR-1; AFCRL-67-0683; AD-665137)

The major products of wind action in the Mojave - dunes, sand sheets, deflation basins, and deeply abraded rock surfaces - are interpreted to have been formed during a past arid interval followed by an extended time of relative eolian quiescence. Evidence for this is found in: (1) dissection of eolian sand deposits by gullies and stream channels; (2) occurrence of stabilized and modified dune surfaces; (3) accumulations of coarse detrital material mantling depositional slopes on eolian sand; (4) weathering of sand-blasted rock surfaces; and (5) gaps between eolian effects and sources of sand which must have produced them. These indicators occur in different combinations at different places. On the basis of comparison with established chronology in other places, the time of maximum wind action is assigned provisionally to the Altithermal, roughly 7500 to 4000 years ago. Present-day wind action is believed to represent a relatively recent reactivation. These findings have significant implications for playa morphology and stratigraphy.
Author (TAB)

N68-19838# Coast and Geodetic Survey, Fredericksburg, Va. Geomagnetic Center.
SYSTEMATIC OCEAN SURVEYS BY THE USC AND GS PIONEER 1961–1963
Douglas J. Elvers, Christopher C. Mathewson, Robert E. Kohler, and Robert L. Moses Sep. 1967 22 p refs
(C/GSDR-1; PB-176534) CFSTI: HC $3.00/MF $0.65

The paper is presented as a report on the PIONEER Ocean Survey data, preliminary to more complete presentations that are in preparation. Geophysical data are shown from an area (lat. 45 degrees N to 55 degrees N and long. 155 degrees 30 minutes W to 164 degrees W) which includes a part of the Pacific Ocean Crustal Plate. The method of systematic surveys is discussed and a large magnetic structure is shown in reference to bathymetric and available gravimetric data. The existence of such a magnetic structure (The Great Magnetic Bight of the Northeast Pacific) suggests that the Pacific crustal plate is more complex than previously thought. The data are presented with the intention that the figures will be useful to scientists planning surveys in the Pacific Ocean.
Author

N68-19857*# Adelaide Univ. (Australia). Dept. of Physics.
A DIURNAL VARIATION OF THE INTENSITY AND ENERGY SPECTRUM OF LOW ENERGY ELECTRONS INCIDENT AT FT. CHURCHILL, CANADA
W. R. Webber Jan. 1968 35 p refs
(Grant NsG-281-62)
(NASA-CR-93740) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Measurements are reported which confirm and extend the observations of a large diurnal intensity variation reported previously. It is concluded that: (1) the effective daytime cut-off near Ft. Churchill is ≈160 MeV; (2) the night-time cut-off is ≈15 MeV but may fluctuate with time; and (3) the transition from day to night conditions occurs within a period of one hour between 1800 and 1900 hours local time. These results are related to recent calculations based on the entrance of particles through the magnetospheric tail and their subsequent motion in the geomagnetic cavity. The re-entrant albedo intensity between 18–160 MeV present in the daytime is compared with other observations of these particles at lower latitudes. The extraterrestrial electron intensity present at night between 15 and 160 MeV is obtained and found to be substantially lower than previous observations have indicated.
Author

N68-19870*# Army Corps of Engineers, Fort Belvoir, Va.
BIBLIOGRAPHY OF REMOTE SENSING OF RESOURCES
Natalie E. Jones Sep. 1966 40 p refs
(NASA Order R-47-009-006)
(NASA-CR-93738) CFSTI: HC $3.00/MF $0.65 CSCL 08G

References on remote sensing of resources that appeared in the open literature between January 1960 and June 1966 are presented alphabetically according to author. A subject index lists articles under various space-related projects, scientific disciplines, spectral fields, radar uses, and photographic techniques.
M.W.R.

N68-19888# Koninklijk Nederlands Meteorologisch Instituut, The Hague.
WIND AND WAVE DATA OF NETHERLANDS LIGHTVESSELS SINCE 1949 [WIND- EN GOLFGEGEVENS VAN NEDERLANDSE LICHTSCHEPEN SINDS 1949]
R. Dorrestein The Hague Staatsdrukkerij 1967 119 p refs
(Rept.-90) CFSTI: HC $3.00/MF $0.65

Frequency tabulations and some characteristic data on wind and wave observations made since 1949 from the Netherlands light vessels in the southern North Sea are presented. Emphasis was on the wave observations, but in view of the close relationships between the waves and the locally observed winds, certain data on the winds and on the correlation between observed waves and winds are also given. The major part of the frequency tabulations was prepared mechanically by means of punched cards containing the three-hourly meteorological observations from the light vessels. However, considerable manual effort was necessary to remove certain imperfections inherent in the mechanically prepared tables.
Author

N68-19902# Alpine Geophysical Associates, Inc., Norwood, N. J.
AREA HH. VOLUME 2: SUMMARY REPORT OF GEOPHYSICAL INFORMATION. PART 1: BATHYMETRY AND SUBBOTTOM PROFILING. PART 2: MAGNETICS Final Report
Douglas W. Edsall and R. Vajk Sep. 1967 152 p refs
(Contract N62306-1688)
(SP-96-HH-2; AD-664680)

This volume is divided into two parts: Part I Bathymetry and Subbottom Profiling, Part II Magnetics. Part I summarizes the bathymetric and subbottom profiling results obtained in Area HH. Area HH is a two ship transit from Charleston, South Carolina and Boston, Massachusetts through the Western North Atlantic, Caribbean Sea and Pacific Ocean to Honolulu, Hawaii. This covers approximately 18,000 miles of geophysical surveying. Part II is a report on the magnetic survey in Area HH. Based on the observed magnetic values a regional field of the total magnetic intensity was constructed. Using the intensity variations of the short wave length component of the residual anomalies magnetic province maps were prepared.
Author (TAB)

N68-19909# Columbia Univ., Palisades, N. Y. Lamont Geological Observatory.
SYNOPTIC MEASUREMENTS OF GEOMAGNETIC FIELD SPECTRA
J. R. Heirtzler and M. J. Davidson Aug. 1967 95 p refs
(Contract Nonr-4259(05))
(CU-1-67; TR-1; AD-665037)

As part of a program of a systematic study of the variation of rapid geomagnetic activity over small distances rapid fluctuations of the total field intensity were recorded with pairs of magnetometers. Recordings were made at three pairs of stations for one day at each of the three station pairs.
Author (TAB)

N68-19938*# Volt Technical Corp., Washington, D. C.
EXPERIMENTAL DATA AS EVIDENCE AGAINST THE HYPOTHESIS ON THE EARTH'S DUST CLOUD [EKSPERIMENTAL'NYYE DANNYYE SVIDETEL'STVUYUSHCHIYE PROTIV GIPOTEZY O PYLEVOM OBLAKE ZEMLI]

B. P. Konstantinov, M. M. Bredov, and E. P. Mazets 28 Mar. 1968 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 174, no. 3, 1967 p 580–582
(Contract NAS5-12487)
(NASA-CR-93742; ST-ID-IM-10696) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Data on the collision frequency with micrometeorites were obtained in the 260 to 650 km altitude range with two piezoelectric sensors aboard the Cosmos 135 satellite. These data, corroborated by Explorer satellite measurements, are used to refute the hypothesis of the existence of a dust cloud around the earth. Sensor design, calibration, and operation are also briefly described. K.W.

N68-19961# Texas A&M Univ., College Station. Dept. of Oceanography.
GROUND TRUTH REQUIREMENTS FOR REMOTE SENSING OF OCEANOGRAPHIC FEATURES
James E. Arnold, Luis R. A. Capurro, Jack F. Paris, and Don Walsh Nov. 1967 23 p Presented at the NASA Ground Truth Conf., Houston, Tex., 27 Nov. 1967
(Contract Nonr-2119(04))
(AD-663458) CFSTI: HC $3.00/MF $0.65

For almost two years the Spacecraft Oceanography Project (SPOC) at Texas A and M University has been studying the use of remotely sensed data from aircraft to determine oceanographic features in the Mississippi Delta region of the Gulf of Mexico. Past experience has shown that the present ground truth program is inadequate due to the nonavailability of research ships and other sophisticated instrument platforms. All the important physical parameters on the sea surface and in the atmosphere above should be measured. TAB

N68-19988# RAND Corp., Washington, D. C.
THE EKMAN VERTICAL VELOCITY IN AN ENCLOSED β-PLANE OCEAN
W. Lawrence Gates Mar. 1968 36 p refs
(Contract NSF C-415)
(RM-5594-NSF)

The vertical flux beneath the surface boundary layer is determined by balancing the divergence induced in this layer by the prescribed wind stress and surface temperature with the divergence of an assumed geostrophic interior flow. In this manner the equilibrium surface height over an enclosed basin is formulated as a boundary-value problem, whose solution leads directly to the Ekman vertical velocity. The corresponding vertical velocity at the top of the boundary layer over a level bottom is also determined, although this is unimportant for the surface layer. Under idealized conditions the solutions for Ekman vertical velocity appear to be reasonable approximations to oceanic upwelling, particularly when the surface thermal forcing is considered, although solutions for more realistic conditions are needed to confirm this. For a specified zonal surface stress and temperature, intense vertical velocity is confined to within about 100 km of the western shore of the basin. The formulation may also be of use in the prescription of boundary values on the vertical velocity for studies of the circulation in the ocean's interior. Author

N68-19989# Texas Instruments, Inc., Dallas. Science Services Div.
WORLDWIDE COLLECTION AND EVALUATION OF EARTHQUAKE DATA
Ray L. Fisher 31 Aug. 1967 140 p refs
(Contract C-104-65; ARPA Order-6207)
(AD-665015)

The report presents and discusses work performed and results obtained under Contract C-104-65 from 28 April through 15 October 1966. During that period, the hypocenter and magnitude programs were tested and then used to process January 1964 data at the computer facilities of the Environmental Science Services Administration (ESSA), Suitland, Maryland, using the CDC 6600 computer. Results of this processing are shown. Author (TAB)

N68-20019# Oregon State Univ., Corvallis. Dept. of Oceanography.
MEASUREMENTS OF SUBSURFACE CURRENTS OFF THE OREGON COAST MADE BY TRACKING OF PARACHUTE DROGUES
Bruce Wyatt, Merritt R. Stevenson, William Gilbert, and June G. Pattullo Oct. 1967 50 p refs *Its* Ref. 67-20
(Contract Nonr-1286(10))
(Rept.-26; AD-665296)

Currents between the surface and 1000 m depth off the Oregon coast have been measured by tracking parachute drogues. The report contains plots of all drogue trajectories and mean velocities, tables of identifying data and wind observations, and listings of programs used in processing the data. Author (TAB)

N68-20034# Technische Hochschule Munchen (West Germany).
MEASURING ELECTRON DENSITY PROFILES OF THE LOWER MAGNETOSPHERE WITH A HIGH-ALTITUDE RESEARCH ROCKET [MESSUNG DES ELEKTRONENDICHTEPROFILS DER UNTEREN MAGNETOSPHAERE MIT EINER HOEHENFORSCHUNGSRAKETE]
Friedhelm Melzner (Ph.D. Thesis) [1967] 27 p refs In GERMAN

A Rubis rocket was used to deliver a transmitter for measuring the electron density up to an altitude of 2000 km. After separation from the rocket, the wave frequency of the transmitter was changed continually and periodically between 0.3 and 3 MHz during the descent. The waves were registered by receivers aboard the descending rocket. The electron density was calculated by Appleton's dispersion equation $n = f(\omega)$ from the transmission characteristics of the distance between transmitter and rocket. Problems encountered during the experiment and suggested improvements are discussed in addition to the instrumentation and the results. Plasma oscillations were registered during the descent of the rocket. It was assumed that the upper limit of the observed frequency band coincides with the hybrid frequency. Transl. by K.W.

N68-20041*# Texas A&M Univ., College Station. Dept. of Oceanography.
OCEANOGRAPHY USING REMOTE SENSORS Status Report, 1 Sep. 1967–1 Jan. 1968
Luis R. A. Capurro 1 Jan. 1968 15 p Sponsored in part by NASA
(Contract Nonr-2119(04))
(NASA-CR-93779; AD-664660) CFSTI: HC $3.00/MF $0.65 CSCL 08C

Summaries are presented of papers dealing with (1) ground truth requirements for aircraft and spacecraft remote sensing of oceanographic features and (2) application for oceanographic uses of the photography taken during the Apollo 501 mission. It is noted that the recognizable surface features were the ice fields of the Antarctic and surface roughness given through the sun glint pattern, and that ocean cloud cover can provide complications for sensing the ocean by infrared methods. Comparison was made of cloud photography with that of satellite photography on the same day and with sea temperature patterns determined by commerical ship reports. There appears to be a time consistent weakening and intensifying of temperature gradients in areas where known currents exist in the Gulf of Mexico. M.W.R.

N68-20058*# Volt Technical Corp., Washington, D. C.
POLAR MAGNETIC DISTURBANCES AND INTRUSION OF CHARGED PARTICLES INTO THE IONOSPHERE [POLYARNYYE MAGNITNYYE VOZMUSHCHENIYA I VTORZHENIYE ENERGICHNYKH CHASTITS V IONOSFERU]

R. G. Afonina and Y. I. Fel'dshteyn 27 Mar. 1968 6 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 6, no. 1, 1968 p 150–152
(Contract NAS5-12487)
(NASA-CR-93794; ST-GM-PF-10691) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The space–time distributions of 77 bay-like disturbances were evaluated. Data were collected at 15 magnetic observatories in the Northern Hemisphere at geomagnetic latitudes $\phi > 60^{\circ}$ during the winter season of the IGY. The evaluated data are used in this paper to prove the regularity of the appearance of polar magnetic disturbances. The equivalent current system at ionospheric heights is given as a generalized representation of the magnitude and direction of the perturbed vector in the horizontal plane. Positive and negative disturbances and the positions of the western and eastern electrojets are discussed. The entire pattern is analyzed in the light of observations obtained by satellites. K.W.

N68-20088# Ghana Univ., Legon. Dept. of Physics.
STUDIES OF THE EQUATORIAL IONOSPHERE USING TRANSMISSIONS FROM ACTIVE SATELLITES Final Scientific Report, 1 Feb. 1964–20 Apr. 1967
John R. Koster 25 Sep. 1967 94 p refs
(Contract AF 61(052)-800)
(AFCRL-68-0020; AD-664902)

Chapter 1 discusses satellite predictions and orbital calculations and gives Fortran II programs and subprograms found useful for these purposes. Chapter 2 finds the azimuthal distribution of irregularities as observed from Legon to be uniform. It verifies their accurate field alignment. The height distribution is given and an upper limit to the thickness of the layer found. Chapter 3 contains a further study of results obtained from Early Bird in 1965, with results on the probability distribution of the Scintillation Index S, its dependence on time, and the power spectrum of the fading signal. Chapter 4 discusses in detail the rate method, the total angle method, and a second order method of analysis of Faraday rotation records, and considers their applicability to the determination of total electron content as a function of position. Numerous examples illustrate the diurnal development of the portion of the equatorial anomaly observable from Legon. Author (TAB)

N68-20207# Technische Hochschule Munchen (West Germany).
DETECTION OF ELECTROMAGNETIC FIELDS IN THE ATMOSPHERE IN A FREQUENCY RANGE OF 0.025 HZ TO 0.25 HZ [NACHWEIS ELEKTROMAGNETISCHER FELDER IN DER ATMOSPHAERE IM FREQUENZBEREICH VON 0.025 HZ BIS 0.25 HZ]
Ludwig Rohrer (Ph.D. Thesis) [1967] 71 p refs In GERMAN

To prove the existence of electromagnetic waves within this frequency range, the vertical electric field and the horizontal, north–south oriented magnetic field were measured and registered simultaneously. The instrumentation consisted of an L antenna for the E field and an induction coil for the H field serving as receivers. Both of the received signal potentials were simultaneously amplified, recorded on magnetic tape, and analyzed for frequency distribution, coincidence of occurrence, and for their relation to field strengths. The results substantiate the various theories of the existence of electromagnetic waves with a periodic duration of about 10 sec. Transl. by K.W.

N68-20227# Royal Inst. of Tech., Stockholm (Sweden). Plasma Physics Div.
A CRITICAL STUDY OF THE POSSIBLE MODES OF PROPAGATION OF Pi 2 MICROPULSATION ACTIVITY OVER THE EARTH'S SURFACE
G. Rostoker [1967] 24 p refs Presented at the Birkeland Symp., Sandefjord, Norway, Sep. 1967
(Repr.-68-02) CFSTI: HC $3.00/MF $0.65

The characteristics of the possible modes by which pi 2 micropulsation activity may propagate over the earth's surface are discussed, and specific characteristics which may be studied experimentally are outlined. The results of previous experimental work are combined with the results of an experiment recently performed by the author to rule out several of the proposed modes of propagation. It is found that pi 2 micropulsations most likely propagate from the auroral zone to midlatitude regions through the lower region of the ionosphere. The energy may be considered to be transferred by a wave mode which has the properties of an electromagnetic wave propagating through a solid conductor. Author (ESRO)

N68-20239# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SEISMIC DISCRIMINATION Semiannual Technical Summary Report, 1 Jul.–31 Dec. 1967
Paul E. Green 31 Dec. 1967 77 p refs
(Contract AF 19(628)-5167; ARPA Order 512)
(ESD-TR-67-597; AD-664872)

Seismic source identification studies have continued during the present reporting period, using a single large array (the Montana LASA), while initial construction, design, and seismic surveying have proceeded for a possible second large array in Norway to work jointly with the LASA and other stations. Work on improving the convenience of machine seismic signal processing is reported, as well as research on earth structure, microseismic noise, and the measurement of long-baseline earth strain using laser interferometers. Author (TAB)

N68-20253# Massachusetts Inst. of Tech., Cambridge.
RESEARCH IN THEORETICAL AND MODEL SEISMOLOGY Final Report, 16 Dec. 1966–16 Nov. 1967
Anthony F. Gangi 16 Nov. 1967 46 p refs
(Contract F19628-67-C-0126)
(AFCRL-67-0600; AD-664941)

Various aspects of model seismology were investigated including: (1) laminated two-dimensional model fabrication and property measurement; (2) the use of variable repetition rates to eliminate reverberations in finite size models; and (3) the measurement of seismic model transducer properties and the comparison with theoretical calculations. In addition, the seismic models were used to determine the diffraction of elastic waves by wedges. Arrays of transducers on seismic models were used in conjunction with a delay-line type, seismic model data processor to demonstrate frequency-wavenumber filtering techniques. A theoretical derivation and demonstration of n-dimensional feedback (or recursion) filtering are given. A computer algorithm for the accurate and automatic determination of seismic array steering delays is presented. Author (TAB)

N68-20284# Wisconsin Univ., Madison. Dept. of Meteorology.
AERIAL SURVEYS OF HUDSON BAY SURFACE TEMPERATURE, 1967
Wayne M. Wendland and Reid A. Bryson Dec. 1967 52 p refs
(Contract Nonr-1202(07))
(TR-36; AD-664817)

Aerial surveys of the surface temperature of Hudson Bay were completed in July, August and October of 1967. An airborne infrared radiation thermometer remotely sensed the surface radiation temperature. The surface temperature patterns are presented for each survey. Certain persistent surface thermal features were found during the first two surveys. In October, the temperature pattern was rather flat, and the large scale features mentioned above, although present, were not as well defined. Because the ice lingers on Hudson Bay into August, it leaves its signature on the surface.

A cold pool (presumably low salinity and therefore relatively low density) was found near the area of last ice. Due to the stratification of the upper layer of the Bay, this cold pool persists throughout most of the ice free season. Author (TAB)

N68-20278*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SCALAR AND COMPONENT WIND CORRELATIONS BETWEEN ALTITUDE LEVELS FOR CAPE KENNEDY, FLORIDA, AND SANTA MONICA, CALIFORNIA

Glenn E. Daniels and Orvel E. Smith Washington Apr. 1968 118 p refs

(NASA-TN-D-3815) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The analysis of large quantities of atmospheric data for use in space vehicle design studies requires the application of statistical methods. An envelope of means or any given percentile derived from a sample of winds taken at discrete altitudes is not necessarily a mean profile and may not define a physically attainable wind profile. Coefficients of correlations with means and standard deviations may be used in a statistical model to derive realistic wind profiles. The statistics presented in this report are based on rawinsonde wind data samples for Cape Kennedy, Florida, and Santa Monica, California, which are greatly improved samples over those previously available. These samples represent an improvement in that they are from a more recent observational period with fewer missing measurements than earlier records and because the data have been carefully edited, checked, and serially completed for missing data. Author

N68-20300# Harvard Univ., Cambridge, Mass. Lab. for Computer Graphics.

SPACE STRAIGHTENING AND FLATTENING

C. Ernesto S. Lindgren 2 Feb. 1968 8 p refs *Its* Geography and the Properties of Surfaces Paper No. 11

(Contract RN00014-67-A-0298-004)

(TR-11; AD-664949)

The paper proposes a solution leading to an approximation, by trial and error, of the problem of straightening and flattening (one to one correspondence with points of an euclidean plane, distances and areas remaining constant) of a non-developable surface. Author (TAB)

N68-20332*# Volt Technical Corp., Washington, D. C.

VARIATIONS OF THE MAGNETIC FIELD AT HIGH LATITUDES AND STRUCTURE OF THE GEOMAGNETIC FIELD IN THE MAGNETOSPHERE [VARIATSII MAGNITNOGO POLY V VYSOKIKH SHIROTAKH I STRUKTURA GEOMAGNIT NOGO POLYA V MAGNITOSFERE]

Ya. I. Fel'dshteyn and A. I. Zaytsev 31 Mar. 1968 5 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 6, no. 1, 1968 p 155–157

(Contract NAS5-12487)

(NASA-CR-93795; ST-GM-10693) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The magnetic field variations at high latitudes and the structure of the geomagnetic field in the magnetosphere are discussed in the light of equatorial boundaries of oval aurora zone, of westerly current vortex and of the equivalent current system DPC during IGY. Reference is also made to the three mechanisms responsible for the magnetic disturbance in the near-polar region. It is suggested that one of them is responsible for rapid phase variations of the perturbed vector, the other two for the appearance of DPC current system. Author

N68-20343*# Volt Technical Corp., Washington, D. C.

MAGNETIC FIELD IN THE TAIL OF THE MAGNETOSPHERE AND ITS DIMENSIONS [MAGNITNOYE POLE V SHLYFE MAGNITOSFERY I YEYE RAZMERY]

G. V. Starkov, Ya. I. Fel'dshteyn, and A. D. Shevnin 29 Mar. 1968 3 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 6, no. 1 p 153–154

(Contract NAS5-12487)

(NASA-CR-93796; ST-GM-PF-10692) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The magnetic field in the tail of the magnetosphere is discussed as a function of the index of magnetic activity and the variations of the dimensions of the latter as a function of different mechanisms. Author

N68-20349# National Environmental Satellite Center, Washington, D. C.

OPERATIONAL PROCESSING OF LOW RESOLUTION INFRARED (LRIR) DATA FROM ESSA SATELLITES Technical Report

Louis Rubin Feb. 1968 42 p refs

(NESC-42) CFSTI: HC $3.00/MF $0.65

The advent of weather satellites has made possible the realistic examination of large scale atmospheric phenomena essential to a more thorough understanding of man's environment. A low resolution infrared (LRIR) sensor, which will be of significant value in examining the generating force behind the general circulation, namely the meridional distribution of the earth's net radiation, was flown on ESSA-3 and ESSA-5. The purpose of this report is to provide a key to the operational data processing of the LRIR data. Hardware and technique are discussed relevant to the data recovery problem, and appropriate references are furnished for detailed study. The operational and archival tape formats are presented and explained. The computational methods used in earth-locating the data and determining the solar zenith and azimuth angles are included. An index to the ESSA-3 LRIR archival tapes is provided. Author

N68-20360# Los Alamos Scientific Lab., N. Mex.

BETA RADIOACTIVITY IN ENVIRONMENTAL AIR AND PRECIPITATION AT LOS ALAMOS, NEW MEXICO, FOR 1966

W. R. Kennedy and Jack W. Aeby 20 Sep. 1967 13 p

(Contract W-7405-ENG-36)

(LA-3663) CFSTI: HC $3.00/MF $0.65

Beta activity of particulate matter in both air and precipitation for 1966 are reported for Los Alamos, New Mexico. The decline in activities that began in the last half of 1963 continued until the middle of 1966. Increases in May, November, and December can perhaps be attributed to the Chinese atmospheric tests. Author (NSA)

N68-20361# Aeronautical Chart and Information Center, St. Louis, Mo. Chart Research Div.

INVESTIGATION OF THE FORMULAE FOR COMPUTING THE QUASIGEOID HEIGHTS, THE DEFLECTION OF THE VERTICAL ON THE PHYSICAL SURFACE OF THE EARTH BY THE ASTRONOMIC-GRAVIMETRIC LEVELING, BY THE MODEL METHOD [LI YUNG MO TI FANG FA YEN CHIU SSU TA TI SHUI CHUN MIEN KAO CH'ENG KUNG SHIH CH'UI HSIEN P'IEN CH'A KUNG SHIH HO T'IEN WEN CHUNG LI SHUI CHUN KUNG SHIH]

Ching-wen Lai and Chi-hsien Ch'iu Dec. 1967 27 p refs Transl. into ENGLISH from Acta Geodetica et Cartographica Sinica (China), v. 5, no. 1, p 47–62

(ACIC-TC-1150; AD-664538) CFSTI: HC $3.00/MF $0.65

The model method is adopted in the paper to study the Stokes formula, the Vening Meinesz formula, and the M. S.

Molodenskii formula (1949, 1960), and their corresponding astronomic-gravimetric levelling formulas. The model No. 1 and the model No. 2 are used for this study. The model No. 1 has been previously used by E. F. Yeremeyev and I. M. Tiron. The model No. 2 is designed by the authors for the purpose of studying the M. S. Molodenskii formula (1949). The following two problems are discussed: (1) The precision of the various formulas in the same model is compared. (2) The effects of the variation of the ground surface angle of inclination on the precision of the various formulas are compared. Through analyses of the results of computation on the basis of the above two points, conclusions are presented. Author (TAB)

N68-20382# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
PHYSICS AND GEOPHYSICS
In its Space Res. Direc. for the Future 1966 p 315-338 refs
(See N68-20376 10-30)

Physical experiments of a basic nature were assessed as to their importance, with both short- and long-term technological requirements and practicability considered. Relativity and gravitation experiments were judged the most critical, and six were selected based on their differing modes of approach: (1) relativistic rotation of the line of apsides (perihelion rotation) of a planet or planetoid; (2) gravitational deflection of light; (3) precession of a spinning body in space; (4) laser tracking of corner reflectors on the moon to determine lunar deceleration; (5) a time-keeping satellite for studying changes in gravitational interaction; and (6) an Eötvös experiment in space for studying the relation of inertial and gravitational mass. Other types of experiments that appear valuable pertain to physical constants, plasmas, and geophysical height sensing. M.G.J.

N68-20423# Royal Inst. of Tech., Stockholm (Sweden). Electron and Plasma Physics Div.
PROBLEMS OF ROCKET-BORNE ELECTRIC FIELD MEASUREMENTS IN THE IONOSPHERE
U. Fahleson, R. Bostroem, and C. G. Faelthammar Dec. 1967 130 p refs Prepared for SAAB Aircraft Co.
(Rept.-67-24) CFSTI: HC$3.00/MF$0.65

Rocket-borne measurements of the electric field in the ionosphere are dealt with. The origin of the electric field is discussed, and the methods of indirect observation of these fields are listed. Assumption on the auroral electrojet circuit and the origin of the motion of the visual and radio aurora are given. Sensitivity requirements are estimated. The methods of electric field measurements, especially the double-probe method based on a system where spherical electrodes are extended far from the rocket nose cone are described. A large number of different effects that might influence the measurement have been analyzed leading to a number of design criteria for a given performance. Characteristic dimensions and certain constructional details are specified. The electric field components along the probe axes are transformed to a suitable non-rotating frame. Finally, the possibility is discussed of producing a probe surface which has a well defined contact potential, so that no variation occurs between the two probes or over the probe surfaces. ESRO

N68-20425# Washington Univ., Seattle. Dept. of Atmospheric Sciences.
UNIVERSAL-TIME CHANGES IN THE GEOMAGNETIC SOLAR QUIET DAILY VARIATION SQ
Masahisa Sugiura and M. Patricia Hagan Jul. 1967 37 p
(Grant NSF- GA-478)
(PB-176073) CFSTI: HC$3.00/MF$0.65

Forty-eight spherical harmonic coefficients, G_{nm} and H_{nm}, up to n=4, m=4 are determined by the method of least squares for the external and internal parts of the scalar magnetic potential of Sq for each UT hour of selected five quiet days, May 20 to 24, 1958, using magnetic data from 66 observatories distributed over the world between dipole latitudes 58.3 degrees N and 47.6 degrees S. Agreement between the input data for the three orthogonal components and the values computed with the determined coefficients is found to be generally excellent except for the observatories near the dip equator where the effect of the equatorial electrojet is large. Remarkable regularity is seen in the UT variations of the spherical harmonic coefficients. Author

N68-20463*# Bellcomm, Inc., Washington, D. C.
METEORIC PHENOMENA IN THE EARTH'S ATMOSPHERE. INVESTIGATIONS OF METEORS, NO. 2
B. L. Kashcheyev, V. N. Lebedinets, and M. F. Lagutin Apr. 1968 295 p refs Transl. into ENGLISH of the Publ. "Meteornyye Yavleniya v Atmosfere Zemli" Moscow, Issled. Meteorov, Izd. Nauka, 1967 p 1-260
(Contract NASw-417)
(NASA-CR-93816) CFSTI: HC$3.00/MF$0.65 CSCL 04A

The physical theory of meteors is discussed, and radiance and ionization observations are reported. Radiowave scattering on meteor trails of various density was considered, and winds and other parameters of the earth's atmosphere were studied from the radio meteor radiance and velocity measurements made by radar of meteors more brilliant than approximately $+7^m$. Velocities were measured by pulse diffraction methods, while the triangular reception of radio waves reflected from meteor trails provided information on radiance. Details are included for orbits of meteor bodies and distribution of meteoritic matter in the solar system. A catalog is presented of data accumulated from more than 12,000 meteors, and a bibliography of 209 references is appended. M.W.R.

N68-20474# Environmental Science Services Administration, Boulder, Colo. Earth Sciences Lab.
ON THE PLANETARY DYNAMO THEORY
Keith L. McDonald Mar. 1968 27 p refs
(ERL-64-ESL-3) GPO: HC$0.25; CFSTI: MF$0.65

This work treats the fluid dynamics of the earth's molten core, in the simpler incompressible case of motions driven by ponderomotive and Coriolis forces. The simultaneous hydromagnetic equations that specify the two divergenceless dependent variables, fluid velocity and magnetic induction, are the amplification equation and the vorticity transport equation. Spherical harmonic expansion of the latter shows that poloidal fluid velocity modes are engendered by self-interaction of both poloidal and toroidal magnetic modes, but that there is no self-interaction of magnetic modes that produces toroidal fluid modes. The principal poloidal or toroidal magnetic mode self-incites only the zonal poloidal fluid velocity modes. These are the principal fluid motions that engender magnetic field reversals as well as large fluctuations in the earth's dipole moment. Both magnetic modes are destroyed by a convective outflow at the higher latitudes with consequent subsidence in the equatorial regions for both direction-senses of the B-field. Author

N68-20500# Royal Aircraft Establishment, Farnborough (England).
VARIATIONS IN AIR DENSITY AT HEIGHTS NEAR 150 KM, FROM THE ORBIT OF THE SATELLITE 1966-101G
D. G. King-Hele and Janice Hingston Aug. 1967 24 p refs Presented at the COSPAR Symp., London, Jul. 1967
(RAE-TR-67171) CFSTI: HC$3.00/MF$0.65

The satellite 1966-101G was launched on 2 November 1966 into an orbit with an initial perigee height of 140 km. A satellite with such a low perigee usually decays within a few days, but 1966-101G was exceptionally dense and remained in orbit until 6 May 1967. Analysis of the changes in its orbital period provides a unique opportunity for studying continuously for six

months the variations in air density at a height near 150 km. This paper records the results of such an analysis, applicable for the (medium) level of solar activity prevailing early in 1967. It is shown that at a height of 155 km the air density is greater by day than by night with the maximum daytime density exceeding the minimum night-time density by a factor of 1.7: in contrast the COSPAR International Reference Atmosphere 1965 predicts that the density should be slightly greater by night than by day. It is also found that the night-time density increases as solar activity increases, and that the density scale height given by CIRA 1965 at heights near 150 km is too low, perhaps by about 20%. Author (ESRO)

N68-20525# Adelaide Univ. (Australia). Dept. of Physics.
INSTRUCTION MANUAL FOR IONOSPHERIC DRIFT MEASUREMENTS. THE DETERMINATION OF IONOSPHERIC DRIFTS FROM THREE-RECEIVER FADING RECORDS
B. H. Briggs [1968] 37 p refs
CFSTI: HC $3.00/MF $0.65

A standard form of a full correlation analysis and calculations required for a dispersion analysis are described for the determination of ionospheric drifts from three-receiver fading records. These methods have application to other geophysical phenomena in which moving patterns occur, including radio star and satellite scintillations, traveling ionospheric disturbances, and magnetometer recordings. Receiver positions and correlation functions are given for the correlation analysis, parameters of the characteristic ellipse and determination of drift velocity are made by a graphical method, and parameters that describe the change of pattern as it moves are determined. Programming of this full analysis for a computer is described, along with the errors and assumptions. For the dispersion analysis, Fourier analyses are made and vector velocities are calculated from phase differences between Fourier components. Results are presented in graphs to show how speed and direction of drift vary with frequency. M.W.R.

N68-20529 Joint Publications Research Service, Washington, D. C.
SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NUMBER 177
3 Apr. 1968 122 p refs Transl. into ENGLISH from Russian (JPRS-44901) CFSTI: $3.00

CONTENTS:

1. ASTRONOMY p 1–6 refs (See N68-20530 10-30)
2. METEOROLOGY p 7–44 refs (See N68-20531 10-20)
3. OCEANOGRAPHY p 45–74 refs (See N68-20532 10-13)
4. TERRESTRIAL GEOPHYSICS p 75–92 refs (See N68-20533 10-13)
5. UPPER ATMOSPHERE AND SPACE RESEARCH p 93–111 refs (See N68-20534 10-13)

N68-20532 Joint Publications Research Service, Washington, D. C.
OCEANOGRAPHY
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 177 3 Apr. 1968 p 45–74 refs (See N68-20529 10-13)

Soviet contributions to oceanography are reviewed, and summary information is presented on the research ships, measuring instrumentation and techniques, and the second Atlantic Expedition of Hydrometeorological Service. Several scientific articles are abstracted. Subject matter pertains to interactions between ocean and atmosphere, atmospheric models, dynamics of a baroclinic layer, vertical attenuation and absorption, sedimentation, seasonal fluctuations of sea levels, bottom sediments, baroclinic instability, ocean circulation, wave motion, atmospheric fluctuations of water vapor concentration and supersaturation, and instrumentation for measuring heat conductivity, thermal properties, and electrical conductivity. M.G.J.

N68-20533 Joint Publications Research Service, Washington, D. C.
TERRESTRIAL GEOPHYSICS
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 177 3 Apr. 1968 p 75–92 refs (See N68-20529 10-13)

Problems involved in using computers in geology are reviewed, along with the geochemical history of the earth, geophysical studies in Siberia and the Far East, and the development of Russian volcanology. Abstracts of scientific articles are presented. These relate to magnetic field pressures, geomorphological structures, seismology, earthquake modeling methods, gravity measurements, minerals and rocks at high pressures and temperatures, structure of the earth's crust, and marine gravimeter observations. M.G.J.

N68-20534 Joint Publications Research Service, Washington, D. C.
UPPER ATMOSPHERE AND SPACE RESEARCH
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 177 3 Apr. 1968 p 93–111 refs (See N68-20529 10-13)

News items are reported on Soviet satellite launchings, space docking problems, self-propelled lunar surface vehicles, unidentified flying objects, and tracking cameras for satellite observations. Several scientific articles are abstracted. Subject matter pertains to cosmic ray research, satellite data plotting, corpuscular streams in winter stratospheric heating, meteors, solar activity burst, and atmospheric absorption of cosmic noise. M.G.J.

N68-20569# School of Aerospace Medicine, Brooks AFB, Tex.
SYNOPSIS OF THE MAGNETOSPHERE
R. Stephen White *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 401–426 refs (See N68-20545 10-04)

Experimental measurements on magnetic and charged particle properties of the earth's cavity resulted in a fast merging magnetic field model where the solar wind bombards the earth's magnetic field and where forces acting on the boundary drag the magnetic field lines away from the boundary and create a long tail. Electron islands in the tail consist of electrons which were accelerated by the electric potential of the merging magnetic field lines; their intensity drops off with distance away from the neutral sheet which is formed by the merging of magnetic field lines and the transformation of the magnetic field energy into kinetic energy. The merger occurs on a line from the dusk to the dawn side in the tail and with the magnetic field lines in interplanetary space on the nose. Most of the phenomena of the magnetic cavity like aurora, magnetic storms, and radiation belts are explained by this theory of fast merging magnetic field lines. G.G.

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N68-19494# Florida Univ., Gainesville. Coll. of Engineering.
THE DIAPHRAGM-CELL METHOD FOR MEASURING DIFFUSION COEFFICIENTS IN BINARY LIQUID MIXTURES

K. E. Bubbins and R. N. Bhatia 1967 42 p refs Submitted for publication *Its* Tech. Paper No. 390
(PB-176514) CFSTI: HC $3.00/MF $0.65

A review is presented of theoretical and experimental aspects of the diaphragm-cell technique for determining diffusion coefficients in binary liquid mixtures. Limitations of the method are discussed, together with necessary experimental precautions, and methods of calculating the differential diffusion coefficient are compared. The literature surveyed covers the development of this technique up to June 1967. Author

N68-19501# Illinois Univ., Urbana. Dept. of Civil Engineering.
A COMPARATIVE STUDY OF TWO- PHOTO VERSUS THREE-PHOTO RELATIVE ORIENTATION
D. E. Moellman Oct. 1967 185 p refs
(Grant NSF GK-776)
(PB-176462) CFSTI: HC $3.00/MF $0.65

Relative orientation plays a very important role in aerotriangulation, whether it is analogue or analytical in nature. Relative orientation may be defined as the process of determining the position and attitude of one of two or more overlapping photographs with respect to the other photographs. Today, there exist numerous processes for the analytical simultaneous relative orientation of stereopairs, stereotriplets, stereomultiplets, subblocks, and complete blocks of photographs. Of these methods, the stereopair which is a natural outgrowth of analogue techniques and the stereotriplet which is mathematically more rigorous are the two methods to be studied and compared to each other in this paper. Results are discussed. Author

N68-19510# Naval Air Systems Command, Washington, D. C.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: SIGNAL SOURCE ATTENUATORS BY PARALLEL I-F SUBSTITUTION (WAVEGUIDE SYSTEMS), (2.6 TO 40.0 GHZ)
1 Jul. 1967 25 p
(NAVAIR-17-20GA-11; PB-176347) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of variable attenuators used for adjusting the output of instruments such as signal generators, signal sources, or test sets utilizing two types of attenuator calibrators currently in use. Author

N68-19519# Illinois Univ., Urbana. Dept. of Civil Engineering.
STRIP AND BLOCK ADJUSTMENTS OF THE ITC BLOCK OF SYNTHETIC AERIAL TRIANGULATION STRIPS
H. Soehngen Jul. 1967 177 p refs To be Presented at the 11th Intern. Congr. of Photogrammetry, Lausanne, Switzerland, Jul. 1968 *Its* Photogrammetry Ser. 5
(Grant NSF GK-776)
(PB-176461) CFSTI: HC $3.00/MF $0.65

A detailed investigation of the use of the ITC Block data for independent strip adjustments and block adjustments has been carried out. Strip adjustments by 2nd and 3rd degree polynomials are studied and used as a comparison for the results of the block adjustments. The block adjustments methods employed use polynomials for simultaneous adjustment solutions. Working programs for block adjustment were developed and are included with the results. Author

N68-19520# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: RADIO TEST SET TS-1325/TRC-75
1 Nov. 1967 12 p
(NAVAIR-17-20AQ-42; PB-176820) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of the TS-1325/TRC-75 radio test set. The test set is used to determine the operating condition of the transmitter and receiver portions of the AN/TRC-75 radio set. Author

N68-19528# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: AC ABSOLUTE VOLTAGE STANDARD RDTEK 146A, 146AG5
15 Aug. 1967 20 p
(NAVAIR-17-20AH-20; PB-176328) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of the Rotek 146A or 146AG5 ac absolute voltage standard. Author

N68-19530# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: DELAY LINE MX-1381/APM-66
15 Sep. 1967 61 p
(NAVAIR-17-20GN-13; PB-176329) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of the MX-1381/APM-66 Delay Line. Author

N68-19533# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: MICROWAVE SIGNAL GENERATOR POLARAD 1107 MICROWAVE SIGNAL SOURCE POLARAD 1207 3.8 TO 8.2 GHZ
1 Sep. 1967 17 p Supersedes PB-174527
(NAVAIR-17-20GG-26; PB-176379; PB-174527) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of the Polarad 1107 microwave signal generator or the Polarad 1207 microwave signal source. Author

N68-19534# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: COUPLER CONTROL TEST SET TS-1324/TRC-75
1 Sep. 1967 9 p
(NAVAIR-17-20AQ-43; PB-176380) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of the TS-1324/TRC-75 coupler control test set, herein referred to as the TI (Test Instrument). Author

N68-19541# Stanford Univ., Calif. Stanford Linear Accelerator Center.
DISPLAY CONTROL OF A CRT-FILM SCANNING SYSTEM
C. R. Dickens Apr. 1967 4 p Presented at the 8th Natl. Symp. of the Soc. for Inform. Display, San Francisco
(Contract AT(04-3)-515)
(SLAB-PUB-299; CONF-670515-2) CFSTI: HC $3.00/MF $0.65

The display control of a CRT-film scanning system for bubble chamber film in high-energy physics is discussed. NSA

N68-19580# American Electronic Labs., Inc., Colmar, Pa.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: SEMICONDUCTOR TEST SETS AN/USM-206 AND AMERICAN ELECTRONICS LABORATORIES, INC. 245 MA
1 Aug. 1967 11 p
(Contract N600(24)-62513)
(NAVAIR-17-20AY-24; PB-176330) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of the AN/USM-206 and American Electronics 245 MA semiconductor tests sets. Author

N68-19562# Naval Air Systems Command, Washington, D. C.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: SPECTRUM ANALYZER POLARAD SA-84WA
15 Aug. 1967 16 p
(NAVAIR-17-20GW-07; PB-176331) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of the Polarad SA-84WA. The Test Instrument provides a visual means of analyzing modulated or unmodulated radio frequency signals at frequencies from 10 to 63,680 mc. Author

N68-19574# Aktiebolaget Atomenergi, Stockholm (Sweden).
CALCULATED ABSOLUTE DETECTION EFFICIENCIES OF CYLINDRICAL NAI (T1) SCINTILLATION CRYSTALS FOR AQUEOUS SPHERICAL SOURCES
O. Strindehag and B. Toliander Feb. 1968 17 p refs
(AE-310) CFSTI: HC $3.00/MF $0.65

Calculated values of the absolute total detection efficiencies of cylindrical scintillation crystals viewing spherical sources of various sizes are presented. The calculation is carried out for 2"×2" and 3"×3" NaI(T1) crystals and for sources which have the radii 1/4, 1/2, 3/4 and 1 times the crystal radius. Source-detector distances of 5–20 cm and gamma energies in the range 0.1–5 MeV are considered. The correction factor for absorption in the sample container wall and in the detector housing is derived and calculated for a practical case. Author

N68-19626 Oklahoma State Univ., Stillwater.
THE DEVELOPMENT AND EVALUATION OF A SHADOW-PHOTOGRAMMETRIC METHOD FOR DETERMINING THE TOPOGRAPHY OF AN OPAQUE SURFACE
John Love, Jr. (Ph.D. Thesis) 1966 191 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-7251

A single lens camera shadow-photogrammetric method has been developed to determine the topography of an opaque surface subject to steady, quasi-steady, or/and transient displacements of the surface. A shadow was projected obliquely onto the surface and a miniature photograph was taken of the pattern of the shadow. The displacement of the shadow from its position on a reference plane can be measured on the photography and by techniques described this displacement can be converted into true location and height above or below the reference plane. The method was applied to a uniform field, and also to the quasi-steady flow of water through a nozzle on a water table. The necessary corrections and the accuracy were examined in detail, and computer programs for the IBM 1620 were developed. In the application illustrated, the results showed that the hydraulic analogy for the nozzle flow with throat injection failed to comply to the analogous gas flow. Dissert. Abstr.

N68-19642*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
DESIGN OF A PRECISION TILT AND VIBRATION ISOLATION SYSTEM
Herbert Weinstock Washington Mar. 1968 169 p refs
(NASA-TR-R-281) CFSTI: HC $3.00/MF $0.65 CSCL 17G

The design of a two axis servomechanism leveling system controlled by gyroscopes and level sensors which is mounted on a massive conventional pneumatic isolation system is presented. At frequencies below 0.012 cps the system is controlled by the level sensors. From 0.012 cps to 25 cps the gyroscopes maintain control. Above 25 cps the servomechanism system is locked out and the test device and massive frame act as a rigid body mounted on springs, resulting in the isolation that would be provided by a damped 1 cps conventional vibration isolation system. The design alternatives for the system, the general design parameters required to meet the performance specification, and the specific components required to achieve these parameters are discussed. The isolation efficiency and other performance functions of a realizable design are presented. The design, assembly, and test results of an experimental single axis full scale model of the servomechanism portion of the system are reviewed. R.N.A.

N68-19651# Library of Congress, Washington, D. C. Aerospace Technology Div.
MEASUREMENT OF LASER OUTPUT
Boris Doncov *In its* Foreign Sci. Bull., Vol. 4, No. 3 Mar. 1968 p 10–15 refs (See N68-19649 10-34)

Soviet efforts on the development of ponderomotive instruments for measuring laser output are examined. The design, accuracy, and characteristics of these devices are discussed. Author

N68-19661# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
ELECTRONIC COUNTERS: INSTRUMENT CALIBRATION PROCEDURE AF-11 Technical Manual
15 Oct. 1967 62 p
(NAVAIR-17-20AF-11; PB-176917) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of electronic counters, a partial list of which is given in appendix A. Author

N68-19680# Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Siebersdorf.
PRECISE MEASURING OF CONTINUOUS BETA SPECTRA [PRAEZISIONSMESSUNG KONTINUIERLICHER BETASPEKTREN]
H. Zemann (Wien Univ.) and D. Semrad (Tech. Hochschule Wien) 1967 14 p refs In GERMAN; ENGLISH summary Presented at the Ann. Austrian Physicists Soc. Conv., Innsbruck, 1967
(SGAE-PH-58/1967)

Instrumental effects that occur in measuring continuous beta spectra by means of a Siegbahn–Slätis intermediate image spectrometer are discussed. Corrections or upper limits for these effects are given. The results are applied to the measurement of the In^{114} and P^{32} spectra, and it is found that both agree with the statistical shape. Author

N68-19742*# Edgerton, Germeshausen and Grier, Inc., Bedford, Mass. Systems Inc.
A STUDY TO DETERMINE THE OPTIMUM DESIGN OF A PHOTOGRAPHIC FILM FOR THE LUNAR SURFACE HAND-HELD CAMERA Final Report
C. W. Wyckoff and J. C. McCue 2 Jun. 1965 161 p refs
(Contract NAS9-3613)
(NAS-CR-92015; B-3076) CFSTI: HC $3.00/MF $0.65 CSCL 14E

The performance of photographic tasks in outer space, and especially on the lunar surface, are discussed and include formation of a latent image and its development, relation between exposure and density, difference between negatives and reversals, image quality, spectral sensitivity, and the fundamentals of color photography. Also described are experiments performed to show the influence of a low-pressure environment on the behavior of several photographic films, and the effects of both high and low temperatures. Low temperatures, as a technique for producing temporary radiation protection of photographic films, shows promise. An experimental color film system was tested and found to be capable of photographing a scene with a large luminance range. A proposed high speed color film which should produce a faithful color record of subjects varying in brightness by more than

10,000 times is described. A second film which will produce high resolution pictures in a blue spectral region, and which, with a filter change, will record infrared pictures is also proposed. Author

N68-19747# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
WAVEGUIDE ATTENUATORS 0 TO 100 DB 2.6 TO 40.0 GHZ PARALLEL I-F SUBSTITUTION
1 Sep. 1967 75 p
(NAVAIR-17-20GA-07; PB-176918) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of waveguide attenuators by I-F substitution using the Weinschel VM-3 attenuator calibrator. Any waveguide attenuator with a nominal value of 100 db or less which operates in the frequency range of 2.6 to 40.0 GHz can be calibrated by this procedure if the system limit of error specified in table 1 is acceptable. Author (TAB)

N68-19803# Army Natick Labs., Mass. Clothing and Organic Materials Lab.
SURVEY OF TRACING AND SENSING SYSTEMS FOR THE DETAILED STUDY OF FIBROUS MATERIALS UNDER TENSILE-IMPACT LOADING
Bernard Rosen and Ross H. Supnik Nov. 1967 52 p refs *Its* Ser. TS-155
(Contract DAAG17-67-C-0167)
(TR-68-28-CM; AD-664781)

A survey was made of prospective tracing and sensing systems which might be applicable to investigations of component and structural deformations within fibrous materials in response to impact tensioning. The candidate systems were generally characterized and compared as to basic suitability and probable adaptability to studies of fabrics, cords, and webbings with 20 - 40% extensibility and under extension rates up to 10,000% per second. Among the more favorably considered were those using magnetic tapes, optical trackers, capacitance transducers, magnetic proximity devices, direct multiflash and high-speed photography, and photography of moire pattern fringes, color of liquid crystals, and radiation and infrared images. Most other systems appeared either inherently, or in their present stages of development, to less well satisfy criteria of reliability, clarity of interpretation, low inertial loading, low restraint on the material, rapid response, and facility for simultaneous sensing of several key deformational factors. Specific recommendations are made for obtaining different evidences and perspectives of events leading up to rupture of the fibrous materials, e.g., optical mapping (high-speed framing photography), thermal mapping (dynamic infrared imaging), shear-rate mapping (dynamic imaging of colored liquid-crystal line coatings), and sound mapping (dynamic 2-dimensional acoustical analysis). Author (TAB)

N68-19804# National Bureau of Standards, Boulder, Colo.
RESPONSE OF PNEUMATIC PRESSURE-MEASUREMENT SYSTEMS TO A STEP INPUT IN THE FREE MOLECULE, TRANSITION, AND CONTINUUM FLOW REGIMES
Jesse Hord 5 Jun. 1967 9 p refs Revised
(NBS-R-439; PB-176586) CFSTI: HC $3.00/MF $0.65

A simplified analysis of the response of pressure-sensing devices and their interconnecting tubing is presented. The results are conveniently presented in the form of time equations, with a fraction of the applied step (usually 63.2%) attained at the sensor as the variable. A single algebraic equation adequately predicts the response of pressure-measuring systems in the free molecule, transition, and continuum flow regimes. Two very simple algebraic equations may be used to predict time response in the free molecule and continuum flow regimes. The formulas are limited where viscous flow occurs, and they are not restricted for free molecule flow. All of the formulas are suitable for field engineering applications. The literature is synthesized by comparing the results from selected references with those of the analysis. Factors influencing transient pressure measurements are reviewed. Author

N68-19835*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 14: ROCKET LAUNCH PHOTOGRAPHY
William A. Bowles Washington 1968 14 p
(NASA-TM-X-52401) CFSTI: HC $3.00/MF $0.65 CSCL 14E

A brief outline is given on the basic operations and purposes of cameras for rocket launch photography, and some of the films and lenses used are mentioned. Various figures and photographs are given to illustrate the significant role of photography in rocket launch operations. B.S.D.

N68-19845# Aerospace Corp., El Segundo, Calif. Lab. Operations.
RADIOMETRIC EQUIPMENT FOR MEASURING OXYGEN ABSORPTION PARAMETERS FROM AN AIRCRAFT
C. J. Carter and E. E. Reber Oct. 1967 64 p refs
(Contract F04695-67-C-0158)
(TR-0158(3230-46)-8; SAMSO-TR-68-32; AD-665109)

The report describes the design, construction, and performance of the radiometric system, known as the 55-GHz radiometer, that was used for measuring the attenuation characteristics of the atmosphere. The system design, and its operation, are described from a basic block diagram point of view. The system performance and calibration are described, with special emphasis on the minimum detectable input temperature difference delta T, and the manner in which it was determined. The radiometer has a tuning accuracy of plus or minus 10 MHz (rms), and a delta T of 4 to 8K across the band from 53.4 to 56.4 GHz. Author (TAB)

N68-19864*# Southern Research Inst., Birmingham, Ala.
DESIGN, FABRICATION AND CALIBRATION OF SIX IRIDIUM VERSUS IRIDIUM-60 RODIUM THERMOCOUPLES Final Report
19 May 1965 34 p refs
(NASA Order R-11)
(NASA-CR-61683; Rept.-7299-1481-11-37) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Six iridium versus iridium-60 rhodium thermocouple assemblies were designed, fabricated, and calibrated. The thermoelectric output of the wire was determined, and the effect of thermal cycling on emf stability was evaluated. After the first exposure, the emf-temperature characteristic was fairly reproducible. The thermocouples performed well in repeated exposures to an oxy-acetylene flame. The major disadvantage of this thermocouple was embrittlement of the wires after high temperature exposures. Author

N68-19869# National Research Council of Canada, Ottawa (Onterio).
AIRBORNE INSTRUMENTATION FOR A CLOUD PHYSICS RESEARCH PROJECT
K. G. Pettit Oct. 1967 77 p refs
(NRC-9978; LR-490) CFSTI: HC $3.00/MF $0.65

Although an immediate objective of this study was the determination of the efficacy of silver-iodide seeding of clouds as a means to augment rainfall over the forest regions of western Quebec, the long-range objective was the advancement of the knowledge of fundamental precipitation mechanisms by the measurement and correlation of rainfall and of the basic properties of cloud and atmospheric parameters. Temporal and geographic control of the dissemination of the silver-iodide seeding material and in-flight measurements of cloud and atmospheric parameters were obtained by the use of a specially instrumented aircraft. This report describes the airborne instrumentation and assesses the accuracy of the measurements. Author

N68-19888# Army Electronics Labs., Fort Monmouth, N. J.
RESONANCE IN ELECTROMECHANICAL TRANSDUCERS USING THE PIEZOELECTRIC EFFECT
Arthur Ballato Dec. 1967 60 p refs
(ECOM-2905; AD-664765)

The report offers a tutorial explanation of the phenomenon of resonance, particularly as it applies to vibrating systems driven by virtue of the piezoelectric effect. The discussion of the mechanical aspects of a vibrating bar is treated in elementary fashion so as not to obscure the physical attributes of the system. The evolution of the concept of an equivalent electrical circuit of a piezoelectric vibrator is traced historically. The parameters of this equivalent circuit are then derived in terms of the physical constants and dimensions of the simple bar resonator. The concept is general, however, and the treatment has equal validity when applied to thickness-shear resonators used as frequency selective elements in modern crystal oscillators and filters. Various characteristic frequencies associated with the circuit are defined and their significance examined. Some of these frequencies appear in connection with IEEE Standard 177 dealing with measurement of the equivalent circuit parameters. In view of the current interest in the measurement procedures, particularly bridge methods, additional useful critical frequencies are introduced with defining equations. One type of bridge measurement method (Schering bridge) is examined in some detail. Procedures by which the circuit parameters may be derived are discussed. Author (TAB)

N68-19887# Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.
STRATOSPHERIC HUMIDITY SENSING WITH THE ALPHA RADIATION HYGROMETER
Frederick J. Brousaides and James F. Morrissey Nov. 1967 29 p refs *Its* Instrumentation Papers No. 133
(AFCRL-67-0604; AD-665123)

General problems involved in sensing atmospheric water vapor in the tropopause and stratosphere are discussed. The specific problem of performing these measurements with a dew-point instrument on a large balloon and the results of a program which included the development of the alpha radiation hygrometer are presented. These results are considered in the light of laboratory investigations and theoretical considerations to determine the validity of the obtained profiles. Author (TAB)

N68-19900# Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center.
CHARACTERISTICS OF TWO COMMERCIAL HIGH-TEMPERATURE ELECTRIC RESISTANCE STRAIN GAGES
M. M. Lemcoe 15 Aug. 1967 103 p refs
(Contract AT(04-3)-700)
(NAA-SR-12118) CFSTI: HC$3.00/MF$0.65

A technical evaluation of two types of commercially available high-temperature electric resistance strain gages is reported. These gages, the BLH Type HT 1212-5A and Microdot Type SG420, were selected for evaluation because of the need for more reliable electric resistance strain gages for high-temperature stress or strain measurements, and process instrumentation for use in the temperature range of 900° to 1200°F. The BLH gage is rated by the manufacturer as a 1000° to 1200°F gage; the Microdot gage is rated as a 900°F gage. Instrumentation of this type is needed to determine or ensure component structural integrity and overall system reliability of fast breeder reactors. These two types of gages were considered to be the most promising of the commercial high-temperature gages for sodium component loop testing. Other types of commercial gages were ruled out because of their temperature limitations, their inability to be properly installed or cured in the field, and other factors which are discussed. The results of this evaluation indicate that the BLH gage is not suitable as a 1200°F gage for measurements on austenitic stainless steel components which are subjected to both steady-state and transient temperature conditions and heating rates in excess of 5°F/sec. The Microdot gage, on the other hand, was found satisfactory for use on austenitic stainless steel components for temperatures up to 900°F, under both steady-state and transient conditions, for heating rates up to at least 30°F/sec. It was therefore concluded that, while there are electric resistance strain gages satisfactory for use up to 900°F, there are not suitable commercial gages for use at 1200°F. The results reported, which include a statistical analysis of the data, related only to the evaluation of the previously mentioned commercial gages. Author (NSA)

N68-19923 Hewlett-Packard Co., Palo Alto, Calif.
ELECTRONIC TECHNIQUES IN GAMMA RAY SPECTROSCOPY AND TIMING
Tracy S. Storer *In* Hewlett-Packard J., v. 19, no. 7, Mar. 1968 p 2–10

An overview of gamma ray energy and timing measurements is presented and attention is given to the detecting and processing of gamma rays by electronic techniques. Capabilities of scintillation, semiconductor, and gas proportional detectors are discussed; and a block diagram of a typical processing system is included as are typical waveforms from such a system and an outline of the processing procedure itself. M.W.R.

N68-19941# Signals Research and Development Establishment, Christchurch (England).
THE DESIGN OF EQUIPMENT FOR MICRO-PHOTOGRAPHY
K. Head Jun. 1967 17 p
(Rept.-67001; AD-664845)

The report describes the design of a complete equipment for micro-photography. Some theoretical considerations are discussed and the camera construction and lighting unit are described in detail. Author (TAB)

N68-19971# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
^{11}B BETA CURRENT THERMAL NEUTRON FLUX DETECTOR
C. N. Jackson, Jr. Apr. 1967 30 p refs
(Contract AT(45-1)-1830)
(BNWL-395) CFSTI: HC$3.00/MF$0.65

The design and performance of a ^{11}B beta current in-core neutron flux detector was investigated during a thermal neutron detector development program. Experimental results, beta current calculations, and some results obtained with a ^{103}Rh self-powered detector are given. Test instrumentation and in-core capsule design are described. Author (NSA)

N68-20044*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
AUTOMATIC PRESSURE TRANSDUCER CALIBRATION SYSTEM
Albert E. Schuler 29 Nov. 1967 13 p
(NASA-TM-X-53678) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The evolution and principles of automatic pressure calibration systems are described. The pressure balance as calibration pressure source and standard, an automatic calibration system for in-place calibration of pressure transducers with data acquisition systems at the test stand, and an automatic fifty-channel pressure transducer calibration system for laboratory evaluation and calibration of pressure transducers are described. Author

N68-20203# Aeronautical Systems Div., Wright-Patterson AFB Ohio.
DEVELOPMENT AND TEST OF THE ENGINE ANALYZER SYSTEM

Hollis G. Zerkle Aug. 1967 171 p refs
(AD-665158)

The report on Project EASY describes the results of the development and 12-month service test of an engine analyzer system combining airborne and ground equipment to automatically collect and process engine performance and stress data to verify that an engine will accomplish the next mission with high confidence, diagnose a faulty engine, and predict maintenance requirements. A detailed description of the EASY equipment, its aircraft installation, and maintenance experience is included. EASY test experience and results with tables, figures, data plots and narrations relating to computer programs, data printouts, analysis, and diagnostic procedures of typical engine malfunctions are presented. Economic justification based upon the results of an extensive Cost Effectiveness Analysis in accordance with DOD Instructions 7041.3, Economic Analysis of Proposed Department of Defense Investments, dated 19 December 1966, is also included. Fleet implementation considerations, pertaining to EASY equipment improvements, installation recommendations, personnel training, and data processing and documentation, are discussed. Although the EASY equipment used in service test was configured for the F-4C/J79-GE-15 and F-105F/J75-P-19W aircraft-engine combinations, modification to accommodate other engine types and subsystems as well as other parameters not presently included can readily be made. The system equipment is general purpose but the installation and data programming must be tailored to each aircraft engine and subsystems combination. Author (TAB)

N68-20277*# Stanford Univ., Calif. Remote Sensing Lab.
FUNDAMENTAL STUDIES RELATING PARTICLE SIZE EFFECTS TO INFRARED SPECTRA Semiannual Report, 1 Jun.–30 Nov. 1967
15 Jan. 1967 24 p
(Grant NGR-05-020-237)
(NASA-CR-93773) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A series of spectra of well known "library" rocks were taken to examine the sensitivity to emissivity variations achieved by raising the internal reference temperature of a spectrometer. Based on these data, the use of a small Δt between sample and reference was incorporated into a circular variable filter (CVF) spectrometer whose data output is compatible with the IBM 360. The Fore optics for this instrument is a 4 inch focal length 1.5 cassegrain. Chopping occurs at the first focal plane, and the incident energy bundle is refocused into the CVF by a KRS-5 lens. The reference body is a black-coated, thermoelectric element bolted to a heat sink. Signal processing electronics are built up from a series of standard modules. The detector feeds into a preamplifier fitted in the detector housing. The demodulator reference signal is derived from a phototransistor-lamp combination on the chopper housing. The CVF is locked onto the same shaft as a digital shaft encoder whose output appears as a series of pulses used to trigger an analog to digital converter. This converter samples the spectrometer, a radiometer, and hand switches used for identification data. The digital data is recorded on magnetic tape which can be read directly into the computer. E.J.S.

N68-20322# Navy Underwater Sound Lab., New London, Conn.
HIGH-SPEED RECORDING ON INFRARED FILM WITH GALLIUM ARSENIDE LIGHT EMITTING DIODES
Milton Green 17 Nov. 1967 24 p refs
(USL-856; AD-664653)

Optical recording on high-speed infrared film with two gallium arsenide intensity-modulated light emitting diodes (LED-10 and LED-11) was experimentally investigated to determine the maximum frequency of recording under the limitations of a system having the following components: (1) An Oscillo Record Camera Model F-248A at f/1.5 with the auxiliary optics of two identical lenses with diameters of 0.19 inch and focal lengths of 0.20 inch; (2) High-Speed Infrared Film; and (3) the LED-10 modulator. The optical system (light source, lens system, and film) limited the frequency of response to about 15 kHz at 295K and 1 MHz at 77K. However, the transport speed of the film (60 in./sec maximum) further limited the maximum detectable frequency to approximately 8 kHz. The optical system limited the spatial frequency to a maximum of about 10 lines/mm. Author (TAB)

N68-20324*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CRYOGENIC TEMPERATURE MEASUREMENT USING PLATINUM RESISTANCE THERMOMETERS
Donald H. Sinclair, Howard G. Terbeek, and Jerry H. Malone Washington Apr. 1968 37 p refs
(NASA-TN-D-4499) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Results of evaluation tests on commercial platinum resistance thermometers (PRT) are reported. Three selective types of compact high-resistance PRT (1000 to 5000 ohms at 273.15°K) have proved to be stable, rugged, and sensitive. Resistance difference ratios as a function of temperature, called Z functions, conform closely to those of the high-quality standard PRT even in the nonlinear cryogenic range. Fixed point calibrations at 273.15°, 77.40°, and 20.20°K plus interpolation between points by Z ratios yield probable uncertainties less than ±0.05°K from 20° to 300°K. Also described are a calibration facility, cryostat, procedures for calibrating in liquid-hydrogen and liquid-nitrogen baths to ±0.02°K, and instrumentation for field installations. Author

N68-20362# Oslo Univ. (Norway). Inst. of Theoretical Astrophysics.
THE TOWER TELESCOPE OF THE OSLO SOLAR OBSERVATORY, HARESTUA
Rolf Brahde 1967 22 p refs
(Contract F61052-67-C-0070)
(AFCRL-68-0022; SR-1(69); AD-664929)

A description of the tower telescope is presented. The concrete building contains a coelostat with two plane mirrors of 46 cm. apertures, an off-axis mirror system with 30 cm. aperture and 2920 cm. focal length, a Newton-Cassegrain system with a 31.7 cm. aperture, 963 cm. focal length of the primary mirror, a horizontal spectrograph with 3 prisms of flint glass, and a grating. Author (TAB)

N68-20411# Naval Research Lab., Washington, D. C.
REPORT OF NRL PROGRESS
Dec. 1967 52 p refs
(PB-176877) CFSTI: HC $3.00/MF $0.65
Contents: The NRL Servohumidiometer. Author

N68-20448# National Aero- and Astronautical Research Inst., Amsterdam (Netherlands).
A SURVEY OF GYROSCOPES AND ACCELEROMETERS WITH PARTICULAR ATTENTION TO MODERN DEVELOPMENTS
H. J. Kranenborg 17 May 1967 112 p refs Prepared for ELDO
(NLR-V-1959) CFSTI: HC $3.00/MF $0.65

This report is a result of a literature study on gyroscopes and accelerometers especially regarding latest developments. Conventional and unconventional types of gyroscopes are dealt with which comprise pick off and torquer devices, and the drift causes and errors appearing in the described types are explained. Weight, performance data etc. are tabulated. Accelerometers, both direct type and force—balance instruments are described. ESRO

N68-20454# Technology, Inc., Dayton, Ohio.
SPECIAL EQUIPMENT FOR MEASUREMENT OF MECHANICAL DYNAMIC PROPERTIES OF EMERGENCY ESCAPE SYSTEMS Final Report, 1 Mar.–20 Nov. 1967

William C. Winstandley, Thomas J. Wittmann, and Melvin C. Eifert Wright-Patterson AFB, Ohio AF Flight Dyn. Lab. Jan. 1968 70 p refs
(Contract F33615-67-C-1373
(AFFDL-TR-68-8; AD-665892)

A Center-of-Gravity/Inertia Meter and an anthropometric chair were designed and fabricated. Incorporated in a portable, integrated structure, the meter permits weighing a test object in two planes and then swinging the object as a pendulum in each of six positions to time the oscillation periods. From the weight and time measurements, a computer program derives the mass and center of gravity of the object and then its inertial properties, including the products of inertia and the principal moments of inertia with their directions. The anthropometric chair permits measurements of the sitting and standing heights and the functional reach of the 1st through the 99th percentile man. After the development of the fabricated meter with the capacity to measure test objects up to 1000 pounds, further study demonstrated the feasibility of designing similar meters with a capacity to handle objects up to 10,000 pounds. The relative merits of measuring techniques for the larger meters were summarized to serve as a guide in designing such meters according to the specific configuration of large crew-compartment escape systems. Author (TAB)

N68-20477# Block Engineering, Inc., Cambridge, Mass.
EXPERIMENTAL STUDY PROGRAM TO INVESTIGATE LIMITATIONS IN FOURIER SPECTROSCOPY Final Scientific Report, 3 Jan. 1967–2 Jan. 1968
Isaiah Coleman and Lawrence N. Mertz Jan. 1968 70 p refs
(Contract F19628-67-C-0167; ARPA Order 450)
(AFCRL-68-0050; AD-665890)

Fourier spectrometry is at a disadvantage compared to conventional scanners insofar as larger dynamic range is required for recording and/or transmitting the signal. Various procedures for minimizing the disadvantage are evaluated. A simulated experimental comparison is made between signal compression techniques and chirping (distribution of the central fringes of an interferogram). The comparison yields approximately a 15 dB improvement for both procedures, though each leave somewhat different residual distortions of the spectrum. The emphasis is given to the chirping procedure, since this is less well known, and ascendence over its problems provides greater insight into Fourier spectrometry. Author (TAB)

N68-20486# Royal Aircraft Establishment, Farnborough (England).
AN INCREMENTAL PHASE CHANGER FOR OFFSETTING TIME AND FREQUENCY STANDARDS
J. P. Bentick Sep. 1967 15 p refs
(RAE-TR-G7230) CFSTI: HC $3.00/MF $0.65

An inexpensive instrument is described which allows small, accurate, frequency changes to be made to the 100 kc/s output from a frequency standard. These frequency changes, which are outside the normal range of control of some standards, are in increments of 50 parts in 10E10 Band are suitable for compensating for the occasional adjustments to Universal Time 2 recommended by the Bureau Internationale de l'Heure. The instrument in no way degrades the long term stability of the standard to which it is attached but it does cause a loss of spectral purity due to the phase and amplitude modulation caused by the method of phase changing. Author (ESRO)

N68-20495# Royal Aircraft Establishment, Farnborough (England).
A PROPOSED ROCKET-BORNE PHOTOMETER
C. T. Farr Jul. 1967 14 p refs Presented at the Conf. on Astron. Opt., London, 10–12 Jul. 1967 Jointly sponsored by Inst. of Phys., Phys. Soc. and Roy. Astron. Soc.
(RAE-TR-67168) CFSTI: HC $3.00/MF $0.65

This paper describes the early stages in the development of an experiment designed to measure the luminance of the sky, at heights above 90 km, from a Skylark-sounding rocket. The development of a logarithmic amplifier to cover the large variation in signal levels expected is outlined. Details are also given of the difficulties involved in making these measurements under daylight conditions. Author (ESRO)

N68-20527# Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires.
DETERMINATION AND STABILIZATION OF THE ALTITUDE OF AN AIRCRAFT IN SPACE USING SEMI-CONDUCTOR DETECTORS [DETERMINATION ET STABILISATION DE L'ALTITUDE D'UN AERONEF PAR DETECTEUR A SEMICONDUCTEUR]
Louis Gilly Nov. 1967 48 p refs In FRENCH; ENGLISH summary
(CEA-R-3281) CFSTI: HC $3.00/MF $0.65

The device studied in this paper can be used as altimeter or as altitude stabilizer. It includes essentially a 'surface barrier' semiconductor detector which counts alpha particles of a radioactive source. Two sources are used corresponding to two possible utilizations of the device. This paper describes experiences made in laboratory which comprises electronic tests and a physic study. Systematic analysis of experimental errors is made comparatively with aneroid altimeters. An industrial device project is given. Author (ESRO)

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N68-19579 Michigan State Univ., East Lansing.
ANALYTICAL INVESTIGATION OF STABILITY OF SQUEEZE-FILM JOURNAL BEARINGS
John Edward Nolan (Ph.D. Thesis) 1966 122 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7585

This paper describes the investigation of stability characteristics of squeeze-film type gas journal bearings by solving the differential equations which describe bearing behavior—Reynolds' equation and the dynamic equations for the journal. Although some approximate results were obtained from small-parameter considerations leading to forms of the Mathieu equation, the greatest accuracy was given by digital-computer solutions based on finite-difference methods. A technique was devised which enables the computer to automatically locate and follow the boundaries of stability maps, even around extremely sharp turns. The associated logic is described in detail and is adaptable to the determination of boundaries in other similar applications. Author

N68-19608*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LUBRICATION AND BEARING PROBLEMS IN THE VACUUM OF SPACE
Edmond E. Bisson Washington 1966 38 p refs Presented at GAMI "Friction Days," Paris, 5–6 Dec. 1966
(NASA-TM-X-52208) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Among the lubrication and bearing problems discussed in this paper are those created by the low ambient pressure existing in space, by the radiative environment, by the absence of a gravitational field, and by the presence of atomic species other than

the normally encountered molecular species. Briefly reviewed are simulation techniques in vacuum chambers and methods for obtaining evaporation rates for oils, greases, metals, inorganic coatings, and polymers. Results of friction and wear experiments are given for unlubricated metals, solid-film lubricant coatings, and gallium films. The effects of crystal structures and other physical properties on vacuum lubrication are described, and the application of rolling-element bearings in spacecraft is considered. K.W.

N68-19611 Oklahoma State Univ., Stillwater.
DYNAMIC CHIP BREAKING—AN EVALUATION OF THE EFFECTS UPON SURFACE MICROGEOMETRY AND FREE CHIP DIMENSION
Phillip Frederick Ostwald (Ph.D. Thesis) 1966 146 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-7269

With greater rates of metal removal possible due to the developments within the past two decades, a need has been overlooked in the region of the breaking, transfer, and disposal of the metal cuttings, called chips, from the process metal cutting. This dissertation investigates the process called "dynamic chip breaking" when a controlled vibration is introduced in the direction of the travel of the feed. This superimposed vibration is given an amplitude such that the continuous ductile chips are broken by the action of the tool. The dynamic chip breaking process can be adjusted to give optimum values for the quality of surface topography and free chip length. Tests indicate that deterioration could be controlled to approximately 20% if the proper operating conditions were chosen. The chip length can be adequately controlled by selecting the frequency and the workpiece rotation. The smaller the amplitude the lower the peak-to-valley surface roughness height. Dissert. Abstr.

N68-19619 Oklahoma State Univ., Stillwater.
A STATISTICAL INVESTIGATION OF SOME MACHINING VARIABLES
Morris Henry Schneider (Ph.D. Thesis) 1966 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-7282

This dissertation deals with the cutting variables which affect surface roughness and power requirements. The statistical technique of analysis of variance has been used in an effort to determine which of the chosen variables, singly or when combined with others, have significant effects on the dependent variables. The statistical technique used can be applied to this type of study. The results indicate that some of the variables previously considered important to power consumption are so insignificant that it may be uneconomical to attempt to control them in day-to-day metal cutting operations. Dissert. Abstr.

N68-19635* Union Carbide Corp., Tonawanda, N. Y. Engineering Dept.
DESIGN, MANUFACTURE AND APPLICATION OF PREFABRICATED VACUUM SUPER INSULATION PANELS TO A 70-INCH DIAMETER CRYOGENIC TEST TANK Final Report
C. R. Lindquist 15 Nov. 1967 129 p
(Contract NAS8-20635)
(NASA-CR-61675) CFSTI: $3.00 CSCL 13H

In order to build a prefabricated panel insulation system for quick installation and easy repair or replacement in the field, a vacuum panel concept was developed. This consists of using layers of fiberglass paper with aluminized Mylar radiation shields interleaved on the warm side; the insulation is encased in a jacket (a laminate of lead and Mylar), and then evacuated and sealed. Development efforts are detailed, and panel fabrication is described. The pre-evacuated super-insulation panels were applied to the 70-inch diameter cryogenic test tank; tests were conducted to determine the thermal performance of liquid hydrogen evaporation from the tank; and a hot leak analysis was performed. The static measuring program for Saturn S-2 stage insulation is included. The results indicate that although the pre-evacuated insulation concept is feasible for application to boost vehicle stages, further development is needed in several areas. M.G.J.

N68-19731*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DRY FILM LUBRICATED BALL BEARINGS FOR GIMBALS OSCILLATING AT SMALL ANGLES IN VACUUM
K. E. Demorest 16 Feb. 1968 26 p refs
(NASA-TM-X-53707) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Present plans for the pitch and yaw gimbal system on the Apollo Telescope Mount (ATM) involve the use of flexible pivots. Because the development problems associated with a flexible pivot system operating at zero g, are unknown, it was decided to test dry lubricated ball bearings under simulated ATM conditions as a back-up to the flexible pivot system. Results of these tests indicate that dry lubricated ball bearings will operate satisfactorily for at least 240,000 cycles at a $\pm 5^{\circ}$ oscillation and at 120,000 psi Hertzian contact stress. The best lubricating system provides a maximum effective coefficient of friction per bearing of .0055 across 10° of oscillation. Author

N68-19752*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL STABILITY STUDIES OF THE HERRINGBONE GROOVED GAS LUBRICATED JOURNAL BEARING
Robert E. Cunningham, David P. Fleming, and William J. Anderson Washington 1968 23 p refs Presented at the 2d Intern. Symp. on Gas Lubrication, Design, and Appl. and Exhibit, Sponsored by ASME, Las Vegas, Nevada, 17–20 Jun. 1968
(NASA-TM-X-52416) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Experimental studies were conducted on six rotors, 1-1/2-inches diameter by 12-1/4-inches long operating in ambient air to high compressibility numbers. Herringbone-groove geometries and clearances were varied to determine their effect on half frequency whirl (HFW). All rotors were operated vertically and without any applied radial load. Results show that half frequency whirl onset is very sensitive to radial clearance. Limited test results indicate that a fully grooved bearing is more stable than a partially grooved one, other parameters being equal. Generally fair agreement between theory and experiment was achieved for predicting HFW onset speeds. Author

N68-19798 Connecticut Univ., Storrs.
THEORY OF ELECTROLESS PLATING: THE ELECTROLESS PLATING OF NICKEL
Irwin Englander (Ph.D. Thesis) 1968 95 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-4545

This thesis is a study of the electroless plating of nickel using sodium hypophosphite as the reducing agent. The author attempts to develop a method for designing a plating solution by using an Elecdropode to measure the hydrogen polarization while sodium hypophosphite is reacting on a nickel surface. In addition, a phanomenologically correct reaction mechanism is also presented. Dissert. Abstr.

N68-19858# Mechanical Technology, Inc., Latham, N. Y.
STEAM BEARING STUDIES. PART 2: THERMAL ENVIRONMENTAL ANALYSIS OF AN EXTERNALLY PRESSURIZED STEAM BEARING
F. C. Hsing and D. E. Dougherty Oct. 1967 45 p refs
(Contract N00014-66-C-0214)
(MTI-67TR77, Pt. 2; AD-665283)

The presence of condensate in a steam lubrication film has been identified as a prerequisite for Steam Hammer instability

in externally-pressurized steam-lubricated journal bearings. This analysis identifies the source or sources of condensate in the bearing film and effects the bearing configuration and operating conditions have on the inception the inception of condensation within the bearing film and in the region of the bearing feed holes. It is shown that jacketing the vapor lubrication film with a manifold of condensing supply steam can maintain the bearing and shaft surfaces of the vapor lubrication film superheated with respect to the local saturation conditions of the film. The thermal analysis also shows that for a wide range of operating conditions a dual manifold arrangement results in essentially isothermal vapor film conditions. This latter result significantly simplifies the analysis of vapor lubricated externally pressurized bearings, since the energy equation for the film is therefore only weakly coupled to the lubrication equation. Although no attempt has been made, as yet, to generate thermal design charts for steam journal bearings, the general agreement between experimental measurements and this analysis along with the flexibility of the thermal model encourage an effort along these lines. Author (TAB)

N68-19861*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PERFORMANCE AND ANALYSIS OF SEALS FOR INERTED LUBRICATION SYSTEMS OF TURBINE ENGINES

Robert L. Johnson, William R. Loomis, and Lawrence P. Ludwig Washington 1968 37 p refs Presented at Gas Turbine Conf. and Prod. Show, Washington, D. C., 17-21 Mar. 1968; Sponsored by the Am. Soc. of Mech. Engr.

(NASA-TM-X-52413) CFSTI: HC $3.00/MF $0.65 CSCL 11A

A nitrogen inerted lubricating system incorporating a 125-mm ball bearing and 6.33-inch diameter face contact seals was operated in a simulated turbine engine sump to 14,000 rpm to explore system feasibility and to identify system problems. The bearing had a DN value of 1.75×10^6 and a maximum Hertz stress of 197,000 psi. In 3-hour screening tests with an improved ester, a synthetic paraffin and a perfluorinated polymeric fluid up to 700°F outer race temperature, the beatings showed no deterioration from the short time running. A modified polyphenyl ether lubricant performed satisfactorily with 600°F outer race bearing temperature both with and without nitrogen inerting. In inerted lubrication system operation, the most troublesome component was the bellows type face contact seal separating the nitrogen gas and oil. Two seals, revised to minimize thermal gradients and employing hydrodynamic lift devices, were designed, analyzed, and the seals were checked experimentally. One revised design employed a hydrodynamic gas bearing for lift and the other obtained lift by means of an oil lubricated spiral groove bearing. Both of these revised designs showed low leakage potential in preliminary tests. Author

N68-19908# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

AUTOMATIC PIPE WELDING USING A MAGNETICALLY DRIVEN ROTATING ARC

Raymond Francis Girard (M.S. Thesis) May 1967 82 p refs

(GAW/EE/67A-2; AD-665128)

A study was made to determine the feasibility of butt welding pipes by means of a magnetically-driven, rotating arc struck between the pipe rims. The two pipes served as electrodes, and two coils placed near the arc formed an opposing magnetic field to provide the Lorentz force necessary for arc rotation. A parametric study of the motion of the arc was performed, and it was concluded that the use of a rotating arc in a welding apparatus employing the Pressure Welding technique is feasible. Limitations of the test model prevented complete evaluation of the process. Author (TAB)

N68-19919# Waterloo Univ. (Ontario). Mechanical Engineering Dept.

THE COST OPTIMISATION OF A SYSTEM WITH RANDOM IMPUTS AND SUBJECT TO SPECIFIED CONSTRAINTS

M. J. Hillier Feb. 1967 10 p refs

(TN-6)

Optimum total costs of allocating a set of tolerances on a corresponding set of random input variables, subject to given constraints on the output variables are obtained. The method is applied to the allocation of manufacturing tolerances on the components of an assembly with specified functional tolerances. Two cases are considered: (a) 100 percent inspection and, (b) statistical quality control of individual components. The analysis is applicable to more general systems. Author

N68-20056*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

ADHESIVE BONDING OF STAINLESS STEELS INCLUDING PRECIPITATION-HARDENING STAINLESS STEELS

R. E. Keith, M. D. Randall, and R. C. Martin [1966] 125 p Prepared by Battelle Memorial Inst.

(Contract DA-01-021-AMC-11651(Z))

(NASA-SP-5085; RSIC-599) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The state of the art of adhesive bonding of stainless steels and precipitation-hardened stainless steels is given. The advantages and disadvantages of adhesive bonding are discussed along with typical joint designs, surface preparation procedures, and environmental factors that influence choice among the available adhesives and processing techniques. The bonding of stainless steels with organic and inorganic adhesives is discussed in relation to the preparation of the adherend surfaces and joints, the tests and standards for selecting the adhesive, and the testing and inspection of the adhesive bond. B.S.D.

N68-20101# Aberdeen Proving Ground, Md. Terminal Ballistics Lab.

DOUBLE SAMPLING FOR DESTRUCTIVE TESTING

George H. Jonas Dec. 1967 41 p refs

(BRL-R-1382; AD-664762)

Equations by Dodge-Romig for double sampling for non-destructive testing have been modified to be usable for destructive testing. Cumbersome expressions have been replaced by suitable approximations so certain manipulations can be made to facilitate the construction of tables. The Consumers Risk is set equal to 0.10 and is evenly subdivided between the two samples as in the Dodge-Romig tables. The tables are comprised of sample sizes, acceptance numbers and lot sizes for various combinations of values of p bar, the process average, p sub t, the lot tolerance fraction defective, and the cost ratios. Author (TAB)

N68-20199*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

RESIDUAL STRESS AND SUBSURFACE HARDNESS CHANGES INDUCED DURING ROLLING CONTACT

David W. Reichard, Richard J. Parker, and Erwin V. Zaretsky Washington Apr. 1968 31 p refs

(NASA-TN-D-4456) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Subsurface residual stress measurements were made on SAE 52100 steel inner races from 207-size deep-groove ball bearings in which ΔH (ball hardness minus race hardness) ranged from −1.1 to 3.5 points Rockwell C. Nominal Rockwell C hardness of the inner and outer races was 63. These bearings had been run at an inner-race speed of 2750 rpm and a radial load of 1320 pounds (5874 N) producing maximum Hertz stresses of 352,000 and 336,000 psi (2425×10^6 and 2315×10^6 N/m^2) at the inner and outer races, respectively. The lubricant was a super-refined naphthenic mineral oil. The residual stress measurements were made of various depths below the inner-race running track surface for a total of 19 of these bearings that had been run for nominally 200, 600, and 1600 hours. The measurements indicated that the maximum compressive residual stresses occur in approximately the same ΔH range for which the maximum fatigue lives were observed.

Additionally, no relation between running time and residual stress could be determined from these measurements. Although a subsurface hardness decrease was evident in all cases, no relation between these changes and ΔH or running time could be determined. Author

N68-20210*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LUBRICANTS FOR INERTED LUBRICATION SYSTEMS IN ENGINES FOR ADVANCED AIRCRAFT
William R. Loomis, Dennis P. Townsend, and Robert L. Johnson Washington 1968 32 p refs To be presented at Natl. Air Transportation Meeting, New York, 29 Apr.–2 May 1968 Sponsored by the Soc. of Automotive Engr.
(NASA-TM-X-52418) CFSTI: HC $3.00/MF $0.65 CSCL 11H

The feasibility of using presently available liquid lubricants in Mach 3 aircraft engines has been investigated with a recirculating inerted lubrication system. Three fluids performed satisfactorily for short durations of three to ten hours in a full scale simulated aircraft bearing and seal assembly at an outer race bearing temperature of 700°F. The principal problem has been with excessive leakage of the oil-side bellows face seals which has accounted for a majority of the test terminations. With only one lubricant (a MIL-L-7808E oil) could bearing failure be blamed on a lack of lubricating ability. An inerted oil-mist once-through system was also tested but with less promising results with only one lubricant running successfully at 600°F bearing temperature. The mist system appears to be limited by its inability to maintain stable bearing temperatures, but it has enough potential to justify further study. Author

N68-20262# Shell Oil Co., Wood River, Ill. Research Lab.
STUDY OF HELICOPTER GEAR LUBRICATION Quarterly Progress Report, Sep.–Nov. 1967
Donald R. Bailey and Stewart J. Beaubien Nov. 1967 18 p refs
(Contract N00019-67-C-0549)
(QPR-2; AD-664663)

The report describes work in the field of helicopter gear lubrication generally, and surface fatigue and fatigue-related phenonena specifically. The performance of several lubricant additives were evaluated in low-speed gear studies and in simulated gear-tooth contacts. Author (TAB)

N68-20325*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
WEAR RATE AND FRICTION COEFFICIENT IN LIQUID NITROGEN AND HYDROGEN OF STEEL SLIDING ON POLYMER LAMINATES (VARIOUS FABRICS AND POLYMERS)
Donald W. Wisander and Robert L. Johnson Washington Apr. 1968 15 p refs
(NASA-TN-D-4463) CFSTI: HC $3.00/MF $0.65 CSCL 11I

The polymers included PTFE (polytetrafluoroethylene), phenolic, epoxy, and melamine; the fabrics included glass, graphite, nylon, and cotton. The reference material used was not a laminate (60% PTFE, 15% glass fiber, and 5% graphite). Wear and friction experiments were conducted with a 3/16-inch- (4.8-mm-) radius hemispherical rider sliding on a flat disk, which was rotated to produce sliding velocities of 2300 feet per minute (701 m/min). The 304 stainless steel riders were under a 1-kilogram load against the polymer laminate disks. The results indicate that the graphite-fabric phenolic laminate is a potentially useful material for sliding contact in liquid nitrogen and that glass-fabric PTFE and graphite-fabric PTFE laminates are potentially useful in both liquid nitrogen and liquid hydrogen. The wear rates and coefficients of friction of 304 stainless-steel riders against the laminates were appreciably lower in liquid nitrogen than in liquid hydrogen. Author

N68-20334# Army Materials and Mechanics Research Center, Watertown, Mass.
A REPORT GUIDE TO RADIOGRAPHIC TESTING LITERATURE, VOLUME 1
Satrak Der Boghosian Dec. 1967 106 p refs
(AMMRC-MS-67-03; AD-664780)

The literature survey is the first volume of a series on radiographic testing. All items included were taken from the holdings of the Department of Defense Nondestructive Testing Information Analysis Center. The intent of the publication is to make available, under one cover, an exhaustive literature survey of the subject matter. By means of these report guides, items of interest may be rapidly and easily retrieved by industrial and scientific users. TAB

N68-20389*# General Electric Co., Schenectady, N. Y.
LEAKAGE TESTING HANDBOOK
J. William Marr Washington NASA Apr. 1968 461 p refs Prepared for JPL
(Contract NAS7-396).
(NASA-CR-952; S-67-1014) CFSTI: HC $3.00/MF $0.65 CSCL 14D

Theory of leakage testing is described; and individual methods of leakage testing, their limitations, sensitivities, and methods of use are delineated. The distinction between leakage measurement and leak location is considered in this handbook that also discusses reasons for leak testing, techniques of using leak testing equipment, flow characteristics encountered in leaks, necessary equipment and safety measures, and standards and calibration. Procedure for writing a leakage specification is given, and a guide is presented for selecting appropriate testing methods. Mass spectrometry, heated anode halogen detection, pressure change procedure, flow measurement, bubble testing, and radioisotope procedures are described. Other techniques considered are the halide torch, sonic detection, light absorption, chemical methods, high voltage discharges, and vacuum gauge responses. Several miscellaneous procedures are noted; and properties of tracer gases and precautions for their use are discussed. M.W.R.

N68-20414# European Space Vehicle Launcher. Development Organization, Paris (France).
THE RELIABILITY OF A SPACE VEHICLE LAUNCHER SYSTEM: A THEORETICAL APPROACH
E. Cambi Mar. 1968 90 p refs
(ELDO-TM-107) CFSTI: HC $3.00/MF $0.65

A tentative theory is proposed, aimed at the evaluation of a reliability test and at the choice of the most convenient testing philosophy. The trial is in any case split into two phases: the adjustment phase and the reliability test proper. The output of the test consists of a likelihood function giving the a posteriori probability that the reliability may take one value or another, rather than a figure representing the experimental reliability. The knowledge of the likelihood curve can be more concisely represented by some of its numerical parameters e.g. the mean value, the variance, the value of the reliability that has a certain probability (confidence) of being exceeded. The resolving formulae are collected. Graphs are given that can ease the computation in the most laborious cases. Author (ESRC)

N68-20433*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THERMAL AND MECHANICAL TREATMENT FOR PRECIPITATION-HARDENING STAINLESS STEELS
C. J. Slunder, A. F. Hoenie, and A. M. Hall [1967] 207 p refs Sponsored jointly with AEC Prepared by Battelle Mem. Inst. for Redstone Sci. Inform. Center
(NASA Order H-76715; Contract DA-01-021-AMC-11851(Z))
(NASA-SP-5089; RSIC-600) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The thermal and mechanical treatments employed in the production and fabrication of precipitation-hardenable stainless steels are discussed. Particular emphasis is directed to the interaction of the processing variables and their effects on fabricability and mechanical properties. Equipment and procedures are described as well as problems likely to be encountered and precautions to be observed in processing. Detailed processing information is presented for the precipitation-hardenable stainless steels considered to be applicable for missile and aerospace applications. Author

N68-20462# Vitro Labs., West Orange, N. J.
DEVELOPMENT OF ELECTROPHORETIC PROCESS FOR COATING T-53 AIR DIFFUSER, EXHAUST DIFFUSER, AND COMBUSTION CHAMBER HOUSING WITH "SERMETEL W", PHASE 3 Technical Report, 7 Nov. 1967–21 Jan. 1968
Kenneth A. Gebler 21 Jan. 1968 22 p
(Contract DAAJ01-67-C-2207(G))
(VL-2488-3-O; AD-665358)

The report covers activities accomplished during program to develop an electrophoretic coating method for the application of Sermetel W (Registered Trademark) to all critical surfaces of the exhaust diffuser, air diffuser and combustion chamber housing of the T-53 Engine. A support fixture for loading, unloading and holding parts during coating was designed, fabricated and installed. A 200 VDC, 50 ampere power supply was checked out in coating experiments on combustion chamber segments and found to be in good working order. Full-scale electrode assemblies were completed for the air and exhaust diffuser components. Satisfactory humidification of coated panels and segments was obtained at 136F and relative humidities of 61 and 66%. TAB

N68-20464# Martin Co., Denver, Colo.
CENTER FOR HIGH ENERGY FORMING
J. D. Mote 1 Jan. 1968 27 p refs Prepared in cooperation with Denver Univ.
(Contract DA-19-066-AMC-266(X); ARPA Order 720)
(AMRA-CR-66-05/12; QR-10; AD-665395)

Energy requirements obtained by running the computer program that predicts strains in a flat circular blank forced into an ellipsoidal die are listed for several sets of parameters. Analysis is continuing on the mechanics of the hydrostatic bulge test, tube bulging, and bulging of thick walled tubes. Final assembly started in December on the electromagnetic forming facility. Energy transfer experiments on pentolite are nearing completion. Progress is reported in explosive welding, shock hardening, ductility during forming, and other studies on the effect of high energy forming on material properties. Better dies have been designed for tube bulging and dome forming. Author (TAB)

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N68-19409# Illinois Univ., Urbana. Dept. of Theoretical and Applied Mechanics.
A SEQUENTIALLY MODULATED RUBY LASER SYSTEM FOR TRANSMITTED AND SCATTERED LIGHT DYNAMIC PHOTOELASTICITY
R. E. Rowlands Oct. 1967 101 p refs
(Grant NSF GK-1645)
(T/AM-304; PB-176464) CFSTI: HC $3.00/MF $0.65

A ruby laser can be satisfactorily sequentially modulated by a low voltage Pockel's Cell to provide a preselected train of intense, Q-switched light pulses whose duration is less than 65 nanoseconds. Such light pulses are monochromatic, coherent and plane polarized. The output from a sequentially modulated ruby laser combined with a smear camera provides a completely satisfactory system for obtaining multiple frame records of high speed events. In particular, it is suitable for both transmitted and scattered light dynamic photoelasticity using 'hard, high modulus' materials. Kodak 2475 Recording Film, although somewhat grainy, is otherwise well suited for high speed photography using ruby lasers. PETN is a relatively safe, suitable explosive for dynamic photomechanics. It is safer and more convenient than lead azide. Author

N68-19922 Cornell Univ., Ithaca, N. Y.
TRANSIENT INTERFERENCE STUDIES OF EMISSION FROM A PULSED RUBY LASER
David Arthur Berkley (Ph.D. Thesis) 1966 197 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-1494

Transient interference patterns produced using the output from a pulsed ruby laser were investigated to obtain new information about the character of the laser output frequency spectrum and the physical processes taking place in the ruby during laser operation. A Young's double pinhole interferometer was used to interfere the output of the laser with a portion of the same output delayed by a given time period that could be varied from 0 to about 200 nanoseconds. The resulting interference pattern was detected by using three high time resolution photodetectors arranged to allow the determination of depth of modulation (or visibility) of the interference pattern and interference pattern spatial position. The theoretical form of the transient interference pattern is analyzed for two beam interference both classically and quantum mechanically and is then related directly to the Young's two pinhole interferometer. The resulting equations form the basis for the experimental analysis of the intensities detected by the interference pattern detectors and related monitoring equipment. Dissert. Abstr.

N68-19935# National Bureau of Standards, Washington, D. C. Metrology Div.
RADIOMETRIC METHODS FOR MEASURING LASER OUTPUT
D. A. McSparron, C. A. Douglas, and H. L. Badger Nov. 1967 19 p refs
(NBS-TN-418) GPO: $0.15

The output of pulsed lasers may be measured by modifications of radiometric methods. The receiver, thermopile or phototube, is used ballistically. It is calibrated by an incandescent-lamp standard of spectral irradiance. The laser beam is attenuated to make its irradiation on the receiver comparable to that from the calibrating source. Attenuation is accomplished by intercepting the entire laser beam on a diffusely reflecting surface. The attenuation factor is determined from direct measurement of the reflectance of this diffusing surface and the geometric constants of the system. Measurement accuracy is dependent upon the accuracy of calibration, and the accuracy with which the spectral sensitivity of the receiver, the spectral transmittance of the bandpass filters, and the reflectance of the diffuser can be determined. Measurements made with different photoelectric receivers agree to about 1.5% using a 1/4-joule pulsed ruby laser as a source. Total uncertainty is estimated to be about 5%. Measurements using these radiometric methods were compared with calorimetric measurements, and a discrepancy of 9% was observed. Author

N68-19944# General Telephone and Electronics Labs., Inc., Bayside, N. Y.
HIGH-ENERGY PULSED LIQUID LASER Semiannual Technical Summary Report, 1 Jul.–31 Dec. 1967
H. Samelson, A. Lempicki, and C. Brecher 31 Dec. 1967 28 p refs
(Contract N00014-68-C-0110; Proj. Defender)
(TR-68-826.2; AD-665014)

The study of high-energy liquid lasers was approached from three aspects: device, material, and optical. Two systems for circulation of the liquid medium in an operating laser were designed and constructed, and one was operated successfully. Problems concerning the optical homogeneity of the laser solution and mechanical abrasion of the pump parts remain to be solved. Most problems of materials preparation were overcome and high-quality solutions can now be prepared reproducibly. Spectroscopic and optical measurements were made, and the transition cross-section for the laser emission was calculated. The emission of the laser was studied in terms of energy output, spectral line breadth, divergence, amplification, and a new phenomenon, self Q-switching. Author (TAB)

N68-19983# United Aircraft Corp., East Hartford, Conn. Research Labs.

RESEARCH INVESTIGATION OF THE MECHANISMS ASSOCIATED WITH GAS BREAKDOWN UNDER INTENSE OPTICAL ILLUMINATION Final Report, 1 Aug. 1964–31 Dec. 1967

David C. Smith and Alan F. Haught 30 Jan. 1968 41 p refs
(Contract Nonr-4696(00); ARPA Order 306; Proj. Defender)
(UACRL-F920272-12; AD-665000)

A high power Q-switched CO2 laser with an output at 10.6 micron wavelength has been developed. In part II, the results of the previous studies of gas breakdown by optical frequency radiation are described along with an outline of the high-power 10.6 micron Q-switched laser development and the gas breakdown studies carried out with this laser source in the present investigations. In part III, the cw and the Q-switched operation of the CO2 gas laser are described in detail and the output power is examined as a function of the various laser parameters. In addition, in this section the operation of the CO2 laser amplifier required for high power operation is also described. In Part IV, the measurements of gas breakdown with 10.6 micron wavelength radiation are presented and the experimental results obtained are compared with a theoretical model of the breakdown. Part V comprises a discussion of the present degree of understanding of the gas breakdown process, and a summary of the results obtained in the studies accomplished under this contract. TAB

N68-20024 Catholic Univ. of America, Washington, D. C.

A LASER-INTERFEROMETRIC TECHNIQUE FOR VIBRATION MEASUREMENT

Harry A. Deferrari (Ph.D. Thesis) 1966 100 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-1250

A photometric device for accurately measuring displacement, frequency, and phase of a sinusoidally vibrating surface is developed and demonstrated. The device is designed for measuring mode shapes of small acoustical transducers in air and in water. The apparatus employs a Michelson interferometer with a multimode laser light source and a multiplier phototube to demodulate and amplify the laser light signals. The method is applied to measurement of vibration throughout the audio frequency range with amplitudes ranging from 1 Å to 30,000 Å. The area on the vibrating surface of an independent vibration measurement can be circular with diameter less than .01 mm which provides excellent mode shape resolution for small vibrators. It is shown that large error can result if the optical path length difference in the interferometer is unequal to zero or different than twice an integer times the laser resonance cavity length. Dissert. Abstr.

N68-20148# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.

OPTICAL DEPOLARIZATION PROPERTIES OF SURFACES ILLUMINATED BY COHERENT LIGHT

W. G. Egan Mar. 1968 23 p Submitted for publication
(RM-408J)

An experimental investigation of the depolarization characteristics of complex surfaces illuminated by 6328 Å laser radiation was made on a large-scale polarimeter. Measurements were made on specimens such as basalt, limonite, volcanic ash, wet and dry sand, gravel, silt, and foliage in various states of freshness. (For powders and aggregates, depolarization appears more pronounced as the size of the individual particles decreases, and as the roughness and porosity of the surface features increases, whereas depolarization appears less pronounced as water is adsorbed or absorbed.) The depolarization signature of foliage served to characterize a particular species, and dryness of the specimens tended to increase the depolarization. As a practical outcome, it appears that additional surface characterization or signature can be obtained through measurement of depolarization characteristics. Author

N68-20280# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.

IMPROVED PERFORMANCE OF PULSED NOBLE GAS ION LASERS WITH AN AXIAL MAGNETIC FIELD, 1 AUGUST–31 OCTOBER 1967

Milton Birnbaum Nov. 1967 18 p refs
(Contract F04695-67-C-0158)
(TR-0158(9230-02)-2; SAMSO-TR-68-52; AD-665110)

The output of pulsed argon ion lasers with an axial magnetic field was studied as a function of magnetic field, current, discharge-tube inside diameter, pressure, and oscillating wavelength. The increased output and efficiency obtained by use of an axial magnetic field clearly indicate its advantages. A simple method of providing the required magnetic field is described. Author (TAB)

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N68-19507# Reactor Centrum Nederland, Petten.

DISLOCATION LOOPS IN NEUTRON IRRADIATED MOLYBDENUM

J. D. Elen Jun. 1967 27 p refs
(RCN-77)

The technique of transmission electron microscopy was used to study the nature of dislocation loops in neutron-irradiated Mo. Consistent results were obtained for a sample of 89 loops of diameter ranging from 90 to 700 Å with an average of 190 Å. They were found to be prismatic loops of 1/2 a (111) Burgers vector, chiefly interstitial in nature. For determination of the inclination of the loops towards the electron beam (here [001]), a mixed technique was used of rotation around a (200) g vector, followed by observation of the larger loops; and of observation of the contrast under operation of the [031] g vector, giving a clear difference in contrast intensity. Author (NSA)

N68-19642*# Mellon Inst., Pittsburgh, Pa.

INVESTIGATION OF STRESS CORROSION CRACKING OF TITANIUM ALLOYS Semiannual Progress Report, 1 Jun.–30 Nov. 1966

E. G. Haney 30 Nov. 1966 25 p refs
(Grant NGR-39-008-014)
(NASA-CR-80328; SAPR-1) CFSTI: HC $3.00/MF $0.65 CSCL 11F

In studies of the mechanism of stress corrosion cracking of titanium alloys, the foil form has been found to be advantageous

The experimental equipment utilized to test foil by dead weight loading has been described. The apparatus and procedures used to make electrode potential and potentiostatic measurements have been presented in detail. The two alloys investigated, Ti–6Al–4V and Ti–13V–11Cr–3Al, were not susceptible to stress corrosion cracking in aqueous solutions with pH values from 0 to 13 and Cl^- ion added. These alloys failed readily in methanol solutions containing less than about one percent water. Electrochemical measurements indicate that the mechanism of cracking was associated with onset of passivation as a function of water content. Author

N68-19577# Bureau of Mines, Rolla, Mo. Metallurgy Research Center.

FERRITE CONTROL BY COBALT ADDITIONS TO A SEMIAUSTENITIC STAINLESS STEEL

M. M. Tilman Apr. 1968 16 p refs

(BM-RI-7107)

The objectives of this research were to determine the practicability of using cobalt as a means of controlling the amount of ferrite in the microstructures of semi-austenitic stainless steels, and to determine the effects of reduced ferrite content on mechanical properties of these steels. Cobalt additions of up to 3 weight % were made to type 17-7 PH^2 (AISI 631) stainless steel. Ferrite contents were determined for alloys in the aged condition, and for alloys quenched from the hot working temperature. Ferrite can be completely eliminated from the microstructure of 17-7 PH stainless steel by additions of cobalt, but complete elimination of the ferrite phase results in lower tensile strength, yield strength, and hardness. Tensile properties, hardness, and impact strength were determined for aged material. A subzero temperature treatment before heat treatment was necessary to obtain maximum strength in the alloys containing cobalt. Addition of 2 weight % cobalt enhances mechanical properties of 17-7 PH stainless steel. Author

N68-19623*# Vitro Labs., West Orange, N. J.

OPTIMIZATION AND EVALUATION OF ELECTROPHORETIC PROTECTIVE COATINGS FOR TANTALUM T-222 ALLOY Final Summary Report, 1 Jul. 1966–27 Oct. 1967

S. J. Klach and M. H. Ortner Dec. 1967 208 p refs

(Contract NAS3-9405)

(NASA-CR-72358) CFSTI: HC$3.00/MF$0.65 CSCL 11F

Coating process parameters including composition, siliconization time, preoxidation time and temperature, and double versus single layer coatings were evaluated in order to improve the oxidation resistance and coating reliability of a variety of silicide coating systems. The coatings were evaluated in terms of oxidation life at 1500°F and 2400°F under cyclic conditions. The most promising systems developed consisted of either $MoSi_2$–$20TiSi_2$ or $MoSi_2$–$40CrSi_2$ coatings deposited over a VSi_2 barrier layer. These systems, at an overall thickness of approximately 2.5 mils, showed the capability of surviving 600 hours exposure at 1500°F and 2400°F, the $MoSi_2$–$20TiSi_2$/VSi_2 coating system yielded oxidation lives of 1398 hours and 824 hours, respectively. The specimen of the 1398 hour test was still intact after terminating the test program. Ductility was lacking, however. Excellent coating reproducibility was exhibited by the $MoSi_2$–$40CrSi_2$/VSi_2 coating system. Eight of the ten specimens tested (4 at each temperature of 1520°F and 2400°F) survived 626 hours of cyclic testing. The excellent performance is attributed to the oxidation resistance and self-healing capability of the VSi_2 underlayer. Author

N68-19692*# Rensselaer Polytechnic Inst., Troy, N. Y.

[INTERDISCIPLINARY MATERIALS RESEARCH INCLUDING FUNDAMENTAL PHYSICS AND CHEMISTRY OF MATERIALS, ENVIRONMENTAL EFFECTS AND RELATED PROBLEMS] Semiannual Progress Report, Sep. 1, 1967–Feb. 29, 1968

Mar. 1968 58 p refs

(Grant NsG-100-60)

(NASA-CR-93718) CFSTI: HC$3.00/MF$0.65 CSCL 11F

As part of an interdisciplinary materials research program, several detailed reports are presented which describe research progress in the following areas: non-crystalline solids, pyrolytic materials, high temperature and solid state chemistry, dispersion strengthened materials, interaction of dislocations with discrete second phase particles in dispersion strengthened alloys, stress corrosion cracking of copper-base alloys, metallic dissolution, mechanical and thermal properties of polymers, polymer characterization, irreversible thermodynamics of the solid state of linear high polymers, relation of molecular structure and intermolecular action in polymer flow and polymer dispersions as a function of temperature and shear rate, ultrasonics, nuclear magnetic resonance in solids, electron spin resonance, X-ray scattering, ultrasonic pulse interferometry, ultralow temperature solid state physics, low temperature physics, and a diffusion facility. R.N.A.

N68-19703# California Univ., Berkeley. Office of Research Services.

INVESTIGATION OF THE APPLICATION OF THE VISIOPLASTICITY METHODS OF ANALYSIS TO METAL DEFORMATION PROCESSES. PART 2: EXTRUSION ATLAS. SUMMARIZED COMPUTER RESULTS IN GRAPHICAL FORM FROM VISIOPLASTICITY STUDIES Final Report, 1 Jun.–31 Dec. 1967

Aly H. Shabaik and Erich G. Thomsen 31 Dec. 1967 404 p ref

(Contract N00019-67-C-0509)

(AD-665017)

The Final Report entitled an Investigation of the Application of the Visioplasticity Method of Analysis to Metal Deformation Processes consists of the following two parts: Part I Results and Analysis from Visioplasticity Studies, Part II Extrusion Atlas - Summarized Computer Results in Graphical Form from Visioplasticity Studies. The report contains computer calculated quantities in graphical form. The data are the result of extrusion studies at room temperature for both one-inch diameter and two-inch diameter split billets. The computed cases shown are only those where steady-state stream lines could be established. Other extrusion results where the grid lines tended to be obliterated for a variety of reasons, mainly surface friction, are not shown. These latter experiments may be successful at such time when improved techniques of grid line marking are used. Table I gives a summary of the conditions of the tracked and computed extrusion data which are presented in graphical form in the report. Author (TAB)

N68-19745*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF COVER GAS PRESSURES ON ACCELERATED CAVITATION DAMAGE

Stanley G. Young and James R. Johnston Washington 1968 33 p refs To be presented at Am. Soc. for Testing and Mater., Honolulu, Hawaii, 29 Jun.–3 Jul. 1968

(NASA-TM-X-52414) CFSTI: HC$3.00/MF$0.65 CSCL 11F

An investigation was made to study the effect of pressure on the resistance to cavitation damage of materials under consideration for components of liquid-metal power conversion systems. A vibratory apparatus was used to subject three materials., AISI 316 stainless steel, L-605, and Stellite 6B to accelerated cavitation damage in sodium at 800°F (700°K). Argon cover gas was used to maintain pressures up to 4 atmospheres (4×10^5 N/m^2) during test. Volume loss and volume-loss rate measurements were used to compare the effects of pressure on the degree of damage. Metallographic studies were conducted to determine the nature of damage. Increasing cover-gas pressure significantly increased cavitation damage to all materials for all exposure times. When the volume-loss rate data were normalized to include only the heavily damaged area of the specimens, the steady-state

volume-loss rate increased as a power function of pressure. Metallographic examination of axially sectioned specimens revealed undercutting and transgranular cracking as well as subsurface deformation for all materials. Author

N68-19787*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PROGRESS IN NASA PROGRAMS FOR DEVELOPMENT OF HIGH TEMPERATURE ALLOYS FOR ADVANCED ENGINES
John C. Freche and Robert W. Hall Washington 1968 19 p refs To be presented at AIAA 6th Intern. Congr. on Aeronautical Sci., Munich, 9–13 Sep. 1968
(NASA-TM-X-52420) CFSTI: HC $3.00/MF $0.65 CSCL 11F

An intensive research effort is underway to provide improved materials for the hot components of advanced aircraft gas turbine engines. Research is being conducted to develop advanced materials for such applications as stator vanes, turbine buckets and disks, combustion chamber liners and the latter compressor stages. Major areas of work deal with the development of nickel and cobalt-base alloys, chromium base alloys, dispersion strengthened materials, composite materials, and protective coatings. Progress in programs dealing with all these areas is described. Author

N68-19801*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EFFECTS OF ALKALI METAL GETTERING AGENTS ON STAINLESS STEEL CORROSION
Wayne Phillips 1 Apr. 1968 32 p refs
(Contract NAS7-100)
(NASA-CR-93727; JPL-TR-32-1239) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Stainless steel tilting capsules were used to study the effect of yttrium gettering in alkali metal corrosion flow streams of lithium, cesium, rubidium, and potassium. Tests carried out at 1500° and 1750°F indicated the feasibility of utilization of type 321 stainless steel for alkali metal containment up to the limit of structural capability, and the possibility of reducing the amount of corrosion and modifying the mode of corrosive attack by the use of flow stream gettering. Author

N68-19939# Massachusetts Inst. of Tech., Cambridge.
SUPERPLASTICITY IN LEAD–TIN ALLOYS. THE FRACTURE OF DUCTILE METALS
Walter A. Backofen and Stanley W. Zehr Dec. 1967 91 p refs
(Contract N00014-67-A-0204-0015)
(AD-664823)

Four alloys from the Pb-Sn system, including the eutectic, were tested in tension over a range of strain rates (approximately 0.00001 to 0.01/sec) from room temperature to 170C, and with large variations in grain size. In general, strain-rate hardening was characterized by a 3-stage pattern of rising and falling strain-rate sensitivity with increasing strain rate. A mechanism is suggested which incorporates non-Newtonian grain-boundary sliding and diffusional (Newtonian) creep acting first in parallel and then in series with non-Newtonian slip creep. It finds support in both mechanical and metallographic measurements. Observed stress:strain-rate relationships can be accounted for, at least approximately, and there is evidence from replica electron microscopy of boundary sliding together with diffusional creep, the latter being reflected in the formation of striated bands primarily along the transverse or tensile-loaded grain boundaries. Author (TAB)

N68-19998# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
STABILITY OF TUNGSTEN AND THORIA DISPERSIONS IN BERYLLIUM
C. R. Watts Dec. 1967 18 p refs
(Contract F04695-67-C-0158)
(TR-0158(3250-10)-9; SAMSO-TR-68-27; AD-664887)

Two candidate refractory materials were selected for a study of the feasibility of producing fine stable dispersions in beryllium. The dispersants used, tungsten and thoria, were introduced by means of powder metallurgical methods. Mixtures of tungsten or thoria with beryllium powder were prepared by the decomposition of ammonium metatungstate or thorium nitrate under hydrogen after precipitation from an aqueous solution containing the powder. As the hot-pressing or sintering temperature for the compositions containing tungsten was raised above 750C, the tungsten reacted to produce WBe12. As the temperature was raised above 850C, WBe22 began to form. Above 1100C, WBe22 was the only beryllide present. The reactions were apparently irreversible. The dispersions of thoria reacted above 750C to produce ThBe13 as the dispersed phase. No other thorium beryllides were produced or expected at higher consolidation temperatures. The temperature at which the starting materials react to produce a beryllide is sufficiently above the 700C usual maximum use temperature for beryllium so that composites may be used containing elemental tungsten or thoria or their respective beryllides. Author (TAB)

N68-19999# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
DYNAMIC SHEAR STRESS–STRAIN–STRAIN RATE RELATION OF IRON
Charles C. S. Yen and Ching H. Yew (Tex. Univ., Austin) Nov. 1967 27 p refs
(Contract F04695-67-C-0158)
(TR-0158(3250-40)-3; SAMSO-TR-68-40; AD-664888)

The mechanical behavior of Armco iron and Ferrovac E iron under torsional impact loading was studied, and an experimental technique similar to the split Hopkinson pressure bar method was used. The shear stress--strain curves were determined at shear strain rates from 1,000,000 to 800 per sec. The tested specimens were examined metallographically. The flow stress of both irons was sensitive to the strain rate and exhibited similar trends. The upper yield point of Armco iron was more sensitive to the strain rate than the Ferrovac E iron when the shear strain rate was higher than 2 per sec. When the shear strain rate was >250 per sec, the Armco iron became brittle and failed catastrophically without appreciable plastic flow. In the brittle fracture, the main cracks ran along about 45 deg to the specimen length, indicating a tension failure instead of shear, and followed the grain boundaries. Author (TAB)

N68-20068# Naval Research Lab., Washington, D. C.
DSSP PROGRAM ON HIGH-STRENGTH MATERIALS EVALUATION OF 350 KSI, 18% NICKEL MARAGING STEEL
Fred R. Stonesifer and Herschel L. Smith Dec. 1967 18 p refs
(NRL-MEMO-1843; AD-664944)

The report describes the study of one material for possible use in the pressure hull of a deep submergence vehicle operating at depths up to 20,000 feet. A pressure hull operating at these depths with a satisfactory weight/displacement ratio requires one to look at materials which might otherwise be classified as too brittle to consider for structural purposes. The material was a 350 ksi, 18% nickel-cobalt-molybdenum maraging steel. Since fracture strength in general decreases with increasing yield strength one would expect somewhat low critical stress-intensity parameter or K sub Ic values at this strength level. However, laboratory heats were giving higher than usual elongations of the order of 10%. It was felt worthwhile to investigate the fracture toughness characteristics of both base plate and welds. Author (TAB)

N68-20131# IIT Research Inst., Chicago, Ill. Technology Center.
VANADIUM ALLOY STUDIES Final Report, 10 Nov. 1966–10 Nov. 1967
10 Jan. 1968 30 p refs
(Contract N00019-67-C-0122)
(IITRI-B6072-6; AD-664672)

Alloys based on V-Cb-Ta with small additions of Ti, Si, and C were arc-melted and fabricated to sheet by warm and cold rolling. Compositions containing 20% Cb, 25% Ta, 0.1% Si, and 0.05% C with up to 0.5% Ti had density-corrected strengths of 260,000-in. at 2000 degrees F and 70,000-in. at 2400 degrees F in the fully annealed condition. Cold-rolled and aged sheet had density-corrected strengths of 1,160,000-in. at -320 degrees F and 800,000-in. at room temperature. The optimum annealing temperature for cold worked stock was in the 2200 to 2300 degrees F range; lower annealing temperatures resulted in a loss of elevated-temperature strength. Author (TAB)

N68-20212# Bureau of Mines, Albany, Oreg. Metallurgy Research Center.
STUDY OF COLUMBIUM AND TANTALUM ALLOYS
Herbert R. Babitzke and Jack G. Croeni Apr. 1968 19 p refs
(BM-RI-7116)

The purpose of this investigation was to optimize the high-temperature properties of columbium and tantalum. Columbium and tantalum were combined with selected alloying elements to achieve solid solution and dispersion strengthening. Fifty-six alloys were evaluated to determine their formability, hardness, strength at elevated temperatures, and oxidation resistance. At 1,200°C, the columbium alloys had strength values of 40,000 psi or greater, and the tantalum alloys had strength values from 50,000 to 58,000 psi. For a 2-hour test period at 1,000°C, weight gains of only 9 and 8 mg/cm^2, respectively, were observed on oxidation testing of two alloys, Cb–15Hf–5W–2Zr–4Al–4Ti–2N and Ta–20Hf–5W–4Al. Author

N68-20233# Bureau of Mines, Reno, Nev. Metallurgy Research Center.
EFFECTS OF BORON AND OF BORON WITH CARBON ON THE MECHANICAL PROPERTIES OF VANADIUM
H. G. Iverson, D. R. Mathews, and J. S. Winston Apr. 1968 21 p refs
(BM-RI-7113)

The effects of adding boron and boron plus carbon to electrorefined vanadium were evaluated with respect to mechanical properties at low temperatures and response to heat treatment. Grain size was significantly decreased with the addition of 0.05 percent boron, the decreases ranging from 30 percent at 800°C to 75 percent at 1,100°C. Increasing the boron content resulted in only a small increase in strength at room temperature, but at 77°K, boron contents of 0.005 to 0.076 percent increased the yield strength of vanadium over 50 percent, from 70,000 psi to 110,000 psi. When boron and carbon were present together, the individual grain-refining effects obtained with either element were retained. Approximately a twofold increase in strength was obtained by age-hardening the alloys containing both boron and carbon. Alloys with only boron additions did not age-harden. Author

N68-20270# Westinghouse Electric Corp., Pittsburgh, Pa. Research and Development Center.
TWINNING AND THE LOW TEMPERATURE MECHANICAL PROPERTIES OF POLYCRYSTALLINE COLUMBIUM, MOLYBDENUM AND CbMo ALLOYS Interim Technical Report, 1 Feb. 1967–31 Jan. 1968
B. J. Shaw 31 Jan. 1968 33 p refs
(Contract Nonr-4442(00))
(Rept.-68-9J7-119-R1; AD-664830)

Mechanical tests in compression and tension over a range of temperatures embracing the ductile-brittle transition temperature have been done on irradiated and non-irradiated molybdenum and three alloys of CbMo. Stress relaxation tests in conjunction with these have been interpreted to show that gross slip and twinning are not involved in the initiation of fracture in those brittle materials. It is also deduced that irradiation damage and alloying act in a similar manner in inhibiting slip and twinning. By use of a strain gauge bridge, it was found that no slip took place within 2 x 10 to the -4th power sec of fracture, and also that gross twinning took place entirely within 2 x 10 to the -4th power sec. Author (TAB)

N68-20328 Illinois Univ., Urbana.
INTERFACIAL REACTIONS RESULTING FROM PRECISION CASTING CHROME STEEL IN ZIRCON MOLDS
Robert Eugene Farris (Ph.D. Thesis) 1968 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-6607

A 5% chrome steel, VDC (H-13), and zircon molds were investigated. Equipment was fabricated to cast the metal under controlled atmospheric conditions. A hot stage microscope was used to observe interfacial reactions at temperatures as high as 2500°F at 100x magnification using both dark field and bright field illumination. Reaction products were identified in microsections using reflected light, reflected polarized light with analyzer, an ARL electron microprobe, and X-ray diffraction. Major reaction product phases identified were zirconia, α hematite, a glassy phase containing iron and minor alloying elements from the steel, and remnants of zircon grain. High chrome, manganese, and vanadium concentrations were found in isolated surface adherent scales on the steel. Opposite to these areas in the mold, greatest depth of oxide penetration was consistently observed. On the metal surface where adherent layers were not found, a continuous phase was observed which had a considerable concentration of zirconia. Below 2450°F the metal surface oxide product does not penetrate and react with the zircon mold until the oxygen pressure is reduced. Under reduced oxygen pressure, which was shown to exist at the metal-mold composite interface in air, penetration and reaction occur at temperatures as low as 2150°F. Dissert. Abstr.

N68-20426# Oak Ridge National Lab., Tenn.
METALS AND CERAMICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1967
Sigfred Peterson, comp. and ed. Nov. 1967 291 p refs
(Contract W-7405-ENG-26)
(ORNL-4170) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. FUNDAMENTAL PROGRAMS, PART 1 p 3–62 refs (See N68-20427 10-26)
2. HIGH-TEMPERATURE MATERIALS PROGRAM, PART 2 p 65–102 refs (See N68-20428 10-17)
3. GENERAL FUELS AND MATERIALS RESEARCH, PART 3 p 105–147 refs (See N68-20429 10-22)
4. REACTOR DEVELOPMENT SUPPORT, PART 4 p 151–226 refs (See N68-20430 10-22)
5. OTHER PROGRAM ACTIVITIES, PART 5 p 229–247 refs (See N68-20431 10-22)

N68-20428# Oak Ridge National Lab., Tenn.
HIGH-TEMPERATURE MATERIALS PROGRAM, PART 2
In its Metals and Ceram. Div. Ann. Progr. Rept. for Period Ending Jun. 30, 1967 Nov. 1967 p 65–102 refs (See N68-20426 10-17)

Materials problems associated with high temperature, high performance reactors for advanced propulsive and electric power systems are described. Particular emphasis is placed on the fabrication of, and complete physical metallurgical evaluation of tantalum-, niobium-, and molybdenum-based alloys. In the tungsten and tungsten alloy tubing fabrication development program, 37 billets were extruded at temperatures ranging from 1650° to 2200°C and extrusion ratios of 3 to 9. Significant process improvement was effected through modifications in press controls and hydraulic system, billet heater, and mandrel design. The thermal conductivity and electrical resistivity are tabulated for four tungsten and tungsten alloy specimens. Refluxing capsules, natural-circulation loops, and

forced circulation loops are used in compatibility studies of cumulative operating times for refractory alloy boiling-potassium systems. Nitride fuels developed for space-nuclear, and liquid-metal fast breeder reactions are described. E.J.S.

N68-20478# Rensselaer Polytechnic Inst., Troy, N. Y.
ELECTRODE KINETIC BEHAVIOR OF METALLIC SURFACES Final Technical Report, 1 Sep. 1962–31 Aug. 1966
Norbert D. Greene Feb. 1968 8 p
(Contract Nonr-591(17))
(AD-665763)

The primary purpose of this program was to relate the electrode kinetic and corrosion behavior of metallic surfaces to metallographic structure and function. Only the most important results are briefly summarized in this final report. Author (TAB)

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N68-19566 National Aerospace Lab., Tokyo (Japan).
STUDY ON HEAT INSULATION MATERIALS FOR ROCKET
Toshiyasu Furuta 1967 7 p refs In JAPANESE; ENGLISH summary
(NAL-TR-145) CFSTI: $3.00

In order to improve the heat insulation effect of the coating on the structural materials for the rocket vehicle, several coating materials were selected, and tested with an oxy-acetylene torch burner. The tested materials were coated on thin stainless-steel discs 38 mm in diameter, and 1 mm thickness. The surfaces of the tested materials were exposed to the flame of the burner, and the temperature rise was measured by a thermo-couple on the opposite surface of the disc. Epoxy resin reinforced with pure silica glass cloth was selected for the base material of the coating; and the effect of mixing with that the powder of potassium alum, special glass, and other inorganic materials, respectively, was especially investigated. Since potassium alum contains water of crystallization, its inclusion would cause a good transpiration cooling effect in addition to the original ablation cooling effect. On the other hand, the mixing of several inorganic materials would increase the heat insulation effect by producing a porous carbonized lamination. The mixed materials gave a good insulation effect. The application of these materials to the nose cone and the nozzle of the rocket is suggested. Author

N68-19604 Oklahoma State Univ., Stillwater.
SYNERGISTIC AND ACCELERATED TESTING EFFECTS ON SPACE THERMAL-CONTROL MATERIALS
Jay Dee Pinson (Ph.D. Thesis) 1966 143 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-7272

The objective of this study was to determine the effects of low density, temperature, proton radiation, and electromagnetic radiation on thermal-control materials. Synergistic type testing as a function of particle radiation and ultraviolet radiation was conducted to evaluate the combined environmental optical degradation. The type of thermal coating was mostly limited to TiO_2/polymethyl siloxane (pigment/vehicle). The thermal-control material optically degraded when exposed to the simulated space environmental parameters. Degradation was found to be a function of proton energy and sample temperature and independent of proton flux. Dissert. Abstr.

N68-19610 Lehigh Univ., Bethlehem, Pa.
A STUDY OF THE BRITTLE FRACTURE OF A VISCOELASTIC MATERIAL AT ELEVATED TEMPERATURES
Philip D. Olear (Ph.D. Thesis) 1966 180 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-4883

The brittle and ductile failure of intentionally cracked samples of polymethyl–methacrylate (PMMA) is experimentally investigated as a function of strain-rate, temperature, material, water content, and crack-tip environment. A definite transition boundary between brittle and ductile failure is defined in terms of the experimental variables. The experimental results indicate that an energy approach may be used as a meaningful engineering fracture criterion. The viscoelastic material is found to behave in a quasi-brittle manner up to the brittle fracture boundary. The critical-stress-intensity factors of PMMA are found to obey a strain-rate/temperature superposition principle. The viscoelastic-fracture energy is deduced from the critical-stress-intensity-factor data, and it also obeys the strain-rate/temperature superposition principle. Dissert. Abstr.

N68-19710*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE ABLATIVE PERFORMANCE OF FIVE PHENOLIC-NYLON-BASED MATERIALS
Allen G. McLain, Kenneth Sutton, and Gerald D. Walberg Washington Apr. 1968 32 p refs
(NASA-TN-D-4374) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Five composite ablation materials which contain various percentages of phenolic resin, powdered nylon, and silica (either as spheres or fibers) were tested in a 20-inch hypersonic arc-heated tunnel. The tests were carried out in air at a stream stagnation enthalpy of 4800 Btu/lbm, a cold-wall aerodynamic heating rate of 119 Btu/ft^2-sec, a stagnation pressure on the model surface of 0.066 atmosphere, and a free-stream Mach number of approximately 5. The data obtained from these tests were used to evaluate the ablative performance of each of the materials and have been compared with theoretical predictions of char-recession rate and (for two of the materials) thermal response. During the tests, char removal was due primarily to oxidation and the char-recession rates were not significantly affected by either mechanical failure of SiO_2-C reactions. The addition of 12.5 percent SiO_2 to the high-density materials produced a significant increase in both char integrity and char-virgin material interface strength but resulted in a decrease in thermal effectiveness. Reasonable agreement between measured and calculated char-recession rates was obtained by assuming chemical equilibrium at the char surface between the pyrolysis gases, the char, and the test stream, with CO as the primary reaction product. Reasonable agreement between measured and calculated thermal response could be obtained only when the char thermal conductivity was assumed to be approximately 1/3 of its measured value. Author

N68-19779# Aerospace Corp., El Segundo, Calif.
ELASTIC PROPERTIES OF ISOTROPIC GRAPHITE, AUGUST 1966–JANUARY 1967
James R. Cost, Kenneth R. Janowski, and Ronald C. Rossi Jan. 1968 35 p refs
(Contract F04695-67-C-0158)
(TR-0158(3250-10)-13; SAMSO-TR-68-28; AD-665108)

Youngs modulus and the shear modulus (at room temperature) are reported for the first time for bulk isotropic graphites of various porosities. Extrapolations to zero porosity indicate Youngs modulus and the shear modulus of theoretically dense isotropic graphite to be 255 kbar and 97 kbar, respectively. Poissons ratio for fully dense isotropic graphite is 0.31, compared with previous literature values of 0.14 and less. Author (TAB)

N68-19793# Pennsylvania State Univ., University Park. Materials Research Lab.

RELATION OF MECHANICAL PROPERTIES TO THE STRUCTURE OF IONIC SOLIDS Quarterly Report, 1 Sep.–30 Nov. 1967

K. Vedam and R. E. Newnham Watertown Army Mater. and Mech. Res. Center 15 Dec. 1967 20 p refs

(Contract DA-19-066-AMC-325(X))

(AMMRC-CR-68-07/6; QR-6; AD-664775)

Detailed analysis of the Berg-Barrett pattern of muscovite mica along with results obtained with Lang technique, condensation of water droplets on freshly cleaved surfaces and rocking curve studies in x-ray diffraction, indicate that the layer structure of muscovite is not truly planar, but appears to be corrugated somewhat similar to the layers in antigorite. Localized interference fringes of Newtonian type were observed with x-rays, in muscovite mica samples. Final details concerning twinning, stacking disorder and chemical homogeneity of fluorophlogopite were worked out. Author (TAB)

N68-19839# Atomic Energy Commission, Washington, D. C. Div. of Technical Information.

RADIATION EFFECTS ON POLYMERS

Marcel Van de Voorde [1967] 16 p refs Transl. into ENGLISH Ind. Atomiques, No. 3/4, 1967 p 61–70

(AEC-TR-6920) CFSTI: HC $3.00/MF $0.65

The effects of nuclear radiation on polymers, as well as its influence of their chemical, mechanical, electrical, and optical properties, ware examined. Applications in the field of accelerators are given, in particular for vacuum chambers and insulators. The damages currently caused by radiation in the CERN proton synchrotron and those that may be anticipated in the future are described. Author (NSA)

N68-19897 Massachusetts Univ., Amherst.

A STUDY OF CRYSTALLIZATION AND ORIENTATION MECHANISMS IN POLYETHYLENE

Clyde Richard Desper (Ph.D. Thesis) 1966 252 p

Available from Univ. Microfilms: HC $11.50/MF $3.25 Order No. 67-5321

The X-ray pole figure technique has been applied to the study of orientation in polyethylene. Wilchinsky-type orientation functions of the form $\langle \cos^2 \phi_{hkl,c} \rangle$ are determined as well as pole figures. These functions are shown to be related to the crystalline contributions to birefringence and infrared dichroism. A new method of presenting these functions on an equilateral triangle plot is introduced. Equations are presented for calculating the orientation functions of weakly-diffracting [hkl] planes for materials of the orthorhombic, tetragonal, hexagonal and cubic systems. Experimental data on blown films yields information on the crystalline and amorphous orientation. The a, b, and c axis orientation functions are all unequal, indicating a morphology more complex than Keller's Type I or Type II models. These results are confirmed by birefringence and infrared dichroism measurements. Similar results are obtained with polyethylene crystallized under orientation. Dissert. Abstr.

N68-19932# Bureau of Mines, Bruceton, Pa. Explosives Research Center.

REVIEW OF IGNITION AND FLAMMABILITY PROPERTIES OF LUBRICANTS Technical Report, 1 Jan. 1966–31 Jul. 1967

Joseph M. Kuchta and Ralph J. Cato Wright-Patterson AFB, Ohio AF Aero Propulsion Lab. Jan. 1968 70 p refs Presented at the Ann. Meeting of Bur. of Mines Explosive Res. Center, Pittsburgh, 28 Sep. 1966

(Contract DO 33(615)-66-5005)

(AFAPL-TR-67-126; AD-665121)

The ignition temperature and flammability properties of combustible fluids are useful in determining safety guidelines and in assessing the fire or explosion hazard which may exist in the environment where the fluids are employed. This report is a compilation and review of such information for over 90 lubricants and hydraulic fluids. Particular emphasis is given to those fluids used in aircraft applications. Data are presented for petroleum base fluids and purely synthetic fluids in air, oxygen, and oxygen-nitrogen atmospheres at pressures from 1/8 to 1000 atmospheres. The temperature requirements for ignitions in heated vessels, by heated wires, and by jets of hot gas are compared over a range of heat source dimensions. Similarly, the flash points, flammability limits, decomposition temperatures, and other related properties are compared and discussed for the various classes of lubricants. Author (TAB)

N68-19973# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.

MECHANICAL DETERIORATION OF MgO BY WATER VAPOR

K. R. Janowski and R. C. Rossi Nov. 1967 30 p refs

(Contract F04695-67-C-0158)

(TR-0158(3250-10)-4; SAMSO-TR-68-31; AD-664890)

The effect of exposure to the laboratory atmosphere on the fracture stress and Youngs modulus of polycrystalline magnesium oxide was studied. The observed degradation of mechanical properties was attributed to chemical attack by atmospheric water vapor. The rate and extent of degradation were bound to be dependent upon the amount and nature of the porosity present within the specimens. Author (TAB)

N68-20079# Illinois Univ., Urbana. Dept. of Theoretical and Applied Mechanics.

PRELIMINARY INVESTIGATION OF MEASUREMENT OF ELASTIC MODULI OF COMPOSITIES USING STRAIN GAGES

Gerald G. Trantina Sep. 1967 23 p refs

(Contract NOw-66-0360-d)

(Rept.-303; AD-664690) CFSTI: HC $3.00/MF $0.65

The elastic moduli of parallel filament glass fiber reinforced epoxy specimens loaded in pure bending was investigated by comparing strain gage and deflection results. Good agreement was obtained after the ambient temperature creep was minimized. Certain precautions were taken to reduce the thermal effects due to the strain gage current. Also, the stiffening effect of the strain gage was analyzed. Author (TAB)

N68-20174 Institute of Paper Chemistry, Appleton, Wis.

AN INVESTIGATION OF THE ROLE OF THE ADHESIVE IN THE STRUCTURE OF PIGMENT-ADHESIVE FILMS

James Leo Burke (Ph.D. Thesis) 1966 143 p

Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-2583

Much of the work concerning the structure of pigment coating films on paper, and the coating properties dependent upon this structure, has been based upon the assumption that pigments pack independently of an adhesive. Such an hypothesis requires that an adhesive ideally fills voids in a predetermined pigment skeleton. The goal of this thesis was to evaluate this hypothesis and thereby to establish the role of the adhesive in the formation of film structure. The idealized void filling hypothesis was evaluated for three pigment-adhesive systems by examining the effects of changes in adhesive content on the specific volume of the films. Films from three systems (starch-clay, polyvinyl alcohol-clay, and latex-clay) were formed on a nonporous substrate, and films from one system (starch-clay) were formed also on a porous substrate. The results of this study showed that the hypothesis of idealized void filling by the adhesive in a pigment film was not valid for any of the systems considered. Dissert. Abstr.

N68-20198# Bureau of Reclamation, Denver, Colo. Concrete and Structural Branch.
CREEP, STRENGTH, AND ELASTICITY OF CONCRETE AT ELEVATED TEMPERATURES
Ken B. Hickey Dec. 1967 25 p
(C-1257; PB-177137) CFSTI: HC$3.00/MF$0.65

Laboratory tests were conducted to determine drying effects on structural concrete exposed to elevated temperature conditions existing in a flash-evaporation water desalting plant. Creep, compressive strength, and modulus of elasticity were measured on concrete dried at temperatures of 73, 130, 180, 230 and 290 deg F over a period of 6 mo. Results show creep at 290 deg F is about 5 times the creep at 73 deg F. Compressive strength is lowest at 180 deg F. Elastic modulus is lowest at 230 deg F and about one-half the modulus at 73 deg F. The variations in concrete properties indicate that possible changes in the composition of concrete occur at temperatures above 180 deg F. The report includes data on strength and moduli changes during storage, strain of unloaded concrete specimens, and weight loss at the different temperatures. Author (TAB)

N68-20215# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
STUDY OF YIELDING PHENOMENA Final Report, 15 Feb. 1966–30 Apr. 1967
D. H. Ender Natick, Mass. Army Natick Labs. Jul. 1967 298 p refs
(Contract DA-19-129-AMC-930(N))
(TR-68-7-CM; AD-664804)

In yielding under constant tensile load, glassy polymethyl methacrylate (PMMA) and glassy polystyrene (PS) exhibit work softening at small strains, followed by strain hardening at higher strains. In this work the initial softening was of most interest. In the constant load experiment, the yield point shows up as a minimum of the deformation velocity vs elongation curve. Measurements were made of the variation of delay time (the time for accelerated elongation to occur under load) with stress and temperature (measured on PS and PMMA) with preorientation birefringence (PS), and with thermal history and water absorption (PMMA). The stress influence on strain rate under constant load is expressible as a stress shift factor. The same stress shift factor governs the stress influence on delay time and deformation rate changes associated with incremental stress changes. The influence of stress on strain rate is reversible. The important contribution to the increase in strain rate under constant load is caused by a true strain softening. The conclusion is drawn that it is a consequence of the disturbance of the annealed positions of the polymer segments. In this picture strain causes the breaking up of the relative order that is brought about in annealing; thus leaving the polymer in a far-from-equilibrium state. TAB

N68-20288# Lockheed Missiles and Space Co., Palo Alto, Calif.
STATISTICALLY ISOTROPIC DEFORMATION OF COMPOSITE MATERIALS
G. N. Savin and L. P. Khoroshun 1967 4 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk Uk. RSR, Ser. Fiz. Tekhn. Mat. Nauk (Kiev), no. 9, 1967 p 804–808
(PB-176851T) CFSTI: HC$3.00/MF$0.65

The problem of determining the macro-modules stress and strain stress of an elastic solid is studied for random distribution of inhomogeneities. Integral equations are given for obtaining the strain and elastic moduli of the solid, and their statistical averages and fluctuations, respectively. Expressions are presented for the average stresses, variances, and correlation moments of the strains. Material bonded by twisted and randomly directed fibers is also considered. B.S.D.

N68-20329*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CRYOGENIC POSITIVE EXPULSION BLADDERS
Raymond F. Lark Washington Apr. 1968 18 p refs Presented at the 1st Ann. Cryog. Polymers Conf., Cleveland, 25–27 Apr. 1967 Sponsored by Case Inst. of Technology
(NASA-TM-X-1555) CFSTI: HC$3.00/MF$0.65 CSCL 21H

The cryogenic flexibility of single and multiple plies of thin polymeric films was experimentally determined at −320° and −423°F. Of the films tested, thin Mylar films of 0.5 mil and less are the most flexible. The relations between cryogenic cycle life and film thickness and also for the number of plies of Mylar film are reported for the same two temperatures. Twist-end-flex cycle life of 0.25-mil Mylar C samples at −423°F ranges from 20 cycles for 1 ply to 400 cycles for 10 plies. Test results for spherical 12-inch diameter multi-ply Mylar, Kapton, and polyethylene film bladders are summarized. Bladder material combinations showing the lowest helium gas porosity after 25 liquid hydrogen positive expulsion cycles are: (1) twelve plies of 0.15-mil Mylar C in combination with 20 plies of 0.1-mil polyethylene film; and (2) ten plies of 0.5-mil Kapton in combination with three plies of 2-mil Nomex-Nylon paper. K.W.

N68-20499# Universidad Autonoma de San Luis Potosi (Mexico). Escuela de Ingenieria.
ASPHALT COVERINGS FOR HIGHWAYS AND FOR AIRPORT RUNWAYS [CARPETAS ASFALTICAS PARA CARRETERAS Y AEROPISTAS]
Ramon Suarez Ramirez 1966 118 p refs In SPANISH
CFSTI: HC$3.00/MF$0.65

An investigation is made of gravel and asphalt materials and the norms of quality that are specified for them, as well as the methods of constructing highways and airport runways with impregnated asphalt layers and the distinct types of asphalt coatings. Also analyzed are the principle methods that are used for the elaboration of the asphalt mixtures. These include both stationary plants and the mobile asphalt laying equipment. Transl. by R.N.A.

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N68-19525# Stanford Univ., Calif. Dept. of Computer Science.
QD-METHOD WITH NEWTON SHIFT
F. L. Bauer 1 Mar. 1967 8 p refs Sponsored in part by NSF
(CS-TR-56; PB-176764) CFSTI: HC$3.00/MF$0.65

Theoretically, for symmetric matrices, a QR-step is equivalent to two successive LR-steps, and the LR-transformation for a tridiagonal matrix is, apart from organizational details, identical with the qd-method. For non-positive definite matrices, however, the LR-transformation cannot be guaranteed to be numerically stable unless pivotal interchanges are made. This has led to preference for the QR-transformation, which is always numerically stable. If, however, some of the smallest or some of the largest eigenvalues are wanted, then the QR-transformation will not necessarily give only these, and bisection might seem too slow with its fixed convergence rate of 1/2. In this situation, Newton's method would be fine if the Newton correction can be computed sufficiently simply, since it will always tend monotonically to the nearest root starting from a point outside the spectrum. Consequently, if one always worked with positive (or negative) definite matrices, there would be no objection to using the now stable qd-algorithm. The report shows that for a qd-algorithm, the Newton correction can very easily be calculated, and accordingly a shift which avoids

under-shooting, or a lower bound. Since the last diagonal element gives an upper bound, the situation is quite satisfactory with respect to bounds. Author

N68-19539# Atomic Energy Centre, Dacca (Pakistan).
A SEQUENCE OF PROBABILITY MEASURES ON THE EUCLIDEAN N-SPACE AND ITS LIMITS
Nasiruddin Ahmed May 1967 9 p refs Submitted for publication
(AECD/EL-6)

Some properties of an indexed family of probability measures $|P_m|$, are presented. It is shown that as m approaches infinity P_m converges to a well-defined probability measure on E^n. Author (NSA)

N68-19597 Cornell Univ., Ithaca, N. Y.
SINGULAR INTEGRALS ON HILBERT SPACE
Michael John Fischer (Ph.D. Thesis) 1966 200 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-1508

Let H be a real separable Hilbert space and let $1<p<\infty$. Let $y \to T_y$ denote the regular representation of the additive group of H acting on L^p (H, normal distribution). Thus if f is a bounded tame function on H, then $(T_y f)(x) = f(x-y)D(x,y)$ where $D(x,y) = \exp[(x,y)/_p - \|y\|^2/_{2p}]$ is the p-th root of the Jacobian of translation by y. The T_y are isometries of $L^p(H)$. If ν is a complex Borel measure on H of bounded variation, let $T_\nu = \int_H T_y d\nu(y)$. It is the object of this thesis to give sufficient conditions on a complex measure μ of bounded variation on H such that if $\nu^{\delta,\rho}(E) = \int_\delta^\rho \mu(E/_t)\ dt/t$ then the strong limit of the $T_{\nu_{\delta,\rho}}$ exists as a bounded operator on $L^p(H)$ as δ tends to zero and ρ tends to infinity. A theorem of this type extends the Calderon–Zygmund theory of singular integral operators on E_N to infinite dimensions. Dissert Abstr.

N68-19598 Oklahoma State Univ., Stillwater.
DESIGN OF NONLINEAR SECOND ORDER DYNAMIC SYSTEMS TO MEET ARBITRARY PERFORMANCE CRITERIA
James Edwin Bose (Ph.D. Thesis) 1966 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-7191

A second-order non-linear differential equation, which describes a large number of physical systems, was investigated to determine a method of designing the system from a set of arbitrary performance specifications. A numerical least squares procedure was used in the fitting of the system equation to a straight-line approximation of the state variables of the system. The results of the numerical solutions were verified experimentally with a second-order nonlinear electrical circuit. The results of the analysis have the following advantages over current methods: (1) Given a set of desired system characteristics, a continuous representation of the state variables of the system can be generated. (2) Constraints can be placed on the velocity and acceleration variables by placing restrictions on the form of the straight-line approximation. Dissert. Abstr.

N68-19600 Oklahoma State Univ., Stillwater.
A STUDY OF INVERSE ARC MAPS AND AN EXAMPLE OF A SPECIAL DECOMPOSITION OF THE 2 CELL INTO NONLOCALLY CONNECTED CONTINUA
John Marshall Jobe (Ph.D. Thesis) 1966 78 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-7238

This paper deals with inverse arc maps, indecomposable continua, monotonic maps, and decompositions of spaces into nonlocally connected continua. All spaces are considered to be at least a Moore Space satisfying Axioms 0 and 1 of Moore. An inverse arc map is defined and fundamental properties of this map are investigated. A study is made of the decomposition of a 2-manifold into a collection of nonlocally connected continua. A sufficient condition that a continuous and monotonic map f be an inverse arc map is that the domain of f be hereditarily locally connected. It is established that any 2-manifold can be decomposed into uncountably many mutually exclusive nonlocally connected continua. Furthermore, there exists a continuous and monotonic inverse arc map f with domain M and range I such that if $y \in I$ then $f^{-1}(y)$ is nonlocally connected. Dissert. Abstr.

N68-19601 Colorado State Univ., Fort Collins.
ESTIMATES OF THE BIVARIATE DISTRIBUTION FUNCTION AT QUANTILE POINTS
Calvin Charles Butler (Ph.D. Thesis) 1966 42 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-5869

Let F(x,y) be the joint distribution function of (X,Y) possessing a continuous probability density function f(x,y). Let the marginal distribution function of X be F_1 with probability density function f_1, the marginal distribution function of Y be F_2 with probability density function f_2. $\zeta_1(s) = F_1^{-1}(S)$, $\zeta(t) = F_2^{-1}(t)$, and $G(s,t) = F(F_1^{-1}(s), F_2^{-1}(t))$. For a random sample (X_k, Y_k), $k=1,2,\ldots$, $X_{n1} < X_{n2} < \ldots < X_{nn}$, $Y_{n1} < Y_{n2} < \ldots < Y_{nn}$ denote the ordered values of the X's and Y's respectively in the first n vectors (X_k, Y_k). Define $Q_n(s,t)$ as the fraction of the first n vectors whose coordinates (X,Y) are such that $X < X_{ni}$, $Y < Y_{nj}$ where i and j are the smallest integers for which $i/n \geq s$, $j/n \geq t$. Dissert. Abstr.

N68-19602 Tennessee Univ., Knoxville.
STOCHASTIC INTEGRAL EQUATIONS
Marshall Wilson Anderson, Jr. (Ph.D. Thesis) 1966 133 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-7469

The purpose of this paper is to investigate the stochastic integral equations (1) $x(s;\omega) = y(s;\omega) + \int_a^b K(s,t)x(t;\omega)dt$ and (2) $x'(s;\omega) = y'(s;\omega) + \int_a^b K(s,t)dx(t;\omega)$. The existence of an $x(s;\omega)$ process on [a,b] which satisfies (1) follows immediately from integral equation theory. A series representation for $x(s;\omega)$ and $R_x(s,t)$ is obtained from the orthogonal representation of $y(s;\omega)$. We are able to calculate stochastic integrals with respect to the $y(s;\omega)$ process in terms of integration with respect to the $x(s;\omega)$ process and conversely. We also achieve a reciprocal relationship between $y(s;\omega) - y(a;\omega)$ and $x(s;\omega) - x(a;\omega)$. An application to certain types of stationary processes (wide sense) is given. Dissert. Abstr.

N68-19644 Syracuse Univ., N. Y.
PRIME ASSOCIATOR-DEPENDENT RINGS
Nicholas Jason Sterling, Jr. (Ph.D. Thesis) 1966 114 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-7096

An associator-dependent ring R is one which satisfies the following identities for all $x, y, z \in R$: (1) $(x, x, x) = 0$, and (2) $\alpha_1(x, y, z) + \alpha_2(y, z, x) + \alpha_3(z, x, y) + \alpha_4(x, z, y) + \alpha_5(z, y, x) + \alpha_6(y, x, z) = 0$, where α_i, $i = 1$–6 are fixed scalars from a field and (1) scalars from a field and (1) does not imply (2). Such a ring R must also satisfy one of the following identities: (3) $\alpha(y, x, x) - (\alpha + 1)(x, y, x) + (x, x, y) = 0$; (4) $(y, x, x) = (x, y, x)$, and (5) $(x, y, z) + (y, z, x) + (z, x, y) = 0$. Some examples are given to show the limitations of any final theory for these rings. Dissert. Abstr.

N68-19646 Syracuse Univ., N. Y.
A LINEAR VECTOR SPACE APPROACH TO NETWORK THEORY
Leon Irvine Wilkinson (Ph.D. Thesis) 1966 163 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-7102

The formalism of linear vector spaces is used to examine several important topics in network theory. Vector space concepts

pertaining to quadratic surfaces and congruency transformations are used to construct a transformation which will simultaneously diagonalize two real, symmetric, positive semi-definite matrices. The construction is made such that it is easily adaptable to use on a digital computer. The application to networks is discussed, and it is shown that the approach allows information concerning the character of the immittance functions to be obtained from knowledge of the rank of the parameter matrices comprising two element type network node to datum admittance or loop impedance matrices. Dissert. Abstr.

N68-19659 Minnesota Univ., Minneapolis.
ON A GENERALIZED GOAL IN FIXED-SAMPLE RANKING AND SELECTION PROBLEMS
Desu Menavala Mahamunulu (Ph.D. Thesis) 1966 90 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8057

We have at our disposal $k \geq 2$ populations $\Pi_1, \Pi_2, \ldots, \Pi_k$ where Π_i is characterized by the one-dimensional distribution function $F(x/\theta_i)$, $\theta_i \in \Theta$ (an interval of the real line), $i = 1, 2, \ldots, k$. Let $\theta_{[1]} \leq \theta_{[2]} \geq \ldots \geq \theta_{[k]}$ be the unknown ordered θ-values and suppose suppose suppose $\theta_{[k-i]} < \theta_{[k-i+1]}$; let c, s, t be positive integers such that $s+t-k+1 \leq c \leq \min(s,t)$. Part I of this investigation is concerned with the selection of subsets of specified size from the given collection of k populations. The experimenter's goal, referred to as Goal I, is to select a subset of size s which contains at least c of the t best populations (the best populations being those with largest θ-values). Part II of this investigation is concerned with the problem of deciding how large the subset size should be (and which one to choose) for fixed values n^* of the common sample size. Dissert. Abstr.

N68-19667 Syracuse Univ., N. Y.
A COMPUTER STUDY OF PERMANENTS OF N-SQUARE (0,1)—MATRICES IN THE CLASS U(K,K)
Jesse Cornelius Lewis (Ph.D. Thesis) 1966 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-7082

In Chapter II (the first chapter is the Introduction) we give a brief exposition on the permanent function in combinatorial mathematics. We also construct a computer program for calculating the permanents of (0,1)—matrices by counting systems of distinct representatives. In Chapter III we use a computer (IBM 7074) to solve additional cases and partition the matrices into permanent subclasses. We also verify a conjecture due to Henryk Minc for matrices of order less than or equal to 7. Chapter IV describes the main computer program in detail. This program has been completely debugged and is very efficient. The table was done for matrices of order less than or equal to 7. Chapter IV describes the main computer program in detail. This program has been completely debugged and is very efficient. We also wrote a double precision program to extend a table for the permanents of the (0, 1)–circulants. The table was done for matrices of order less than or equal to 7. We extended the table to matrices of order 15. Dissert. Abstr.

N68-19670 Duke Univ., Durham, N. C.
A SEQUENCE OF NUMBERS RELATED TO THE EXPONENTIAL FUNCTION
Fredric Timothy Howard (Ph.D. Thesis) 1966 48 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-6872

Bernoulli numbers are defined, and the case of $n = 2$ is defined during the study of a sequence of numbers related to the exponential function. A recurrence formula is used to compute the first few values of A_n, and some of the main properties of A_n are listed. It is noted that little is known about either the numerator or the sign of A_n. Dissert. Abstr.

N68-19675# Northwestern Univ., Evanston, Ill. Technological Inst.
ON THE COMPUTATION OF CANONICAL CORRELATIONS
Claude Cohen and Adi Ben-Israel Mar. 1968 13 p refs *Its* Systems Res. Mem. No. 199
(Grant NSF GP-7550)

The problem of canonical correlations is formulated and solved as an eigenproblem without the usual non-singularity assumptions. The proposed algorithm has the additional advantage that the matrices in the eigenproblems are symmetric. Author

N68-19684 Oklahoma State Univ., Stillwater.
DIGITAL COMPUTER ANALYSIS OF SYSTEMS WITH NONLINEAR ELEMENTS
Jack Milfred Walden (Ph.D. Thesis) 1966 130 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-7308

The analysis of large physical systems becomes increasingly difficult as the size of the system increases. The inclusion of nonlinear elements makes hand calculation impractical for anything but small systems. The high-speed digital computer, which is now available to almost every engineer, provides a powerful tool for this analysis. However, the programming of analysis methods requires their reduction to sequences of simple and methodic operations. Most conventional analysis techniques, which were developed for hand calculation, do not lend themselves to computer programming. Transform methods and frequency-response analysis can be aided by computer programming but are not easily adapted for total computer solution. It appears that the most direct method is to resort to direct numerical solution of the actual differential and algebraic equations of the mathematical model of the system. The state-space equations are uniquely suited for this purpose. Dissert. Abstr.

N68-19685 Oklahoma State Univ., Stillwater.
CONVEX KERNELS
Charles Richard Smith (Ph.D. Thesis) 1966 52 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-7286

This dissertation is an expository discussion of the known results concerning the convex kernel of star-shaped sets in real linear spaces. The two basic problems investigated are: (1) given a non-convex set, find and characterize its convex kernel and (2) given a convex set, find a non-convex set for which the given set is its convex kernel. The literature was surveyed thoroughly and comparative analyses were made to determine the present status of the study of convex kernels. The major results in this area of mathematics are stated as theorems and are explained through a sequence of examples. A collection of unsolved problems is provided for the interested student of convexity. For a certain class of compact connected sets in E_n, $n \geq 2$, it can be shown whether or not the sets have a non-empty convex kernel by examining sub-collections of n+1 boundary points of each set being considered. Dissert. Abstr.

N68-19687 Oklahoma State Univ., Stillwater.
A THEORY OF SUBJECTIVE INFERENTIAL PROBABILITY
William Talbert Tucker, Jr. (Ph.D. Thesis) 1966 79 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-7305

A study of the concept of a subjective inferential theory of probability is made. The term plausibility is used to name this form of subjective probability. Plausibilities are real numbers in the interval [0, 1] and are assigned to propositions that are elements of an arbitrary Boolean algebra for which an abstract concept of truth and falsity has been defined. This concept of truth or falsity is also employed in defining independent propositions. The primary problem investigated is this. If initially the plausibilities of certain of the propositions are given and then some of these are known to change by a known amount, then how should the plausibilities

of the remaining propositions change. This problem is a special case of the general inference problem. A solution is obtained by axiomatically developing a theory of plausibilities and a total information function and then minimizing the total information function subject to restrictions. The plausibilities developed have most of the properties that elementary probabilities have. Dissert. Abstr.

N68-19697 California Univ., Los Angeles.
COVERINGS OF GROUPS OF CHEVALLEY TYPE
John Moss Grover (Ph.D. Thesis) 1966 88 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-6909

Here the results on coverings of Chevalley groups are extended to twisted groups. First, a class of groups, called groups of Chevalley type, are defined abstractly by a set of axioms. It is shown that groups of Chevalley type have a universal central extension unique up to isomorphism—the covering group. Groups of Chevalley type have unique Bruhat decompositions and are equal to their commutator subgroups. It is proven that twisted groups are of Chevalley type if the field has at least seven elements. The cases where the field has fewer elements are not covered. Also left open in the question of what other groups are of Chevalley type. These include, at least, Chevalley groups, twisted groups, and commutator subgroups of central extensions of these, with the exceptions noted. Dissert. Abstr.

N68-19698 Washington Univ., Seattle.
THE PLANCHEREL TRANSFORM ON THE NILPOTENT PART OF G_2 AND SOME APPLICATIONS TO THE REPRESENTATION THEORY OF G_2
Kenneth Irwin Gross (Ph.D. Thesis) 1966 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-7038

In this thesis we develop the Plancherel transform on the nilpotent part V of the exceptional simple complex Lie group G_2. V is a simply-connected, connected nilpotent Lie group of complex dimension six. It is well-known that the simple complex Lie algebra of type G_2 can be realized as the derivation algebra of the so-called generalized Cayley algebra over the complex numbers. In the first chapter we describe this Cayley algebra and utilize the above fact to obtain a concrete realization of the Lie algebra of type G_2 as a Lie algebra of complex 7×7 matrices, and to obtain the group G_2 as a closed subgroup of GL(7,C), where C denotes the complex numbers. The second chapter is concerned with the Plancherel transform on V. We determine all the irreducible unitary representations of V up to unitary equivalence, and single out those representations involved in the Plancherel transform. The third, and final, chapter is devoted to some applications of the Plancherel transform to the representation theory of G_2. Dissert. Abstr.

N68-19736 Washington Univ., St. Louis, Mo.
THE APPLICATION OF CO-TOPOLOGY TO MINIMAL TOPOLOGICAL SPACES
Giovanni Anthony Viglino (Ph.D. Thesis) 1966 65 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-7051

The main objective of the paper is the application of cotopology to minimal topological spaces. Co-topology is the study of the subcollection, Ξ, of the topological structures for a space X = (X, J), where Ξ is defined as follows. Let $\beta[X]$ represent the set of open bases for J, then $\Xi = \bigcup_\beta \{\beta \mid \beta \in \beta[X]\}$ where J_β is the topology generated by the complements of the closures of elements in β. The space (X, J_β) is called the co-space of X with respect to β, or simply a co-space of X. A co-space of X which is homeomorphic to X under the identity map is said to equal X. A space which equals each of its co-spaces is called coinvariant. It is proved that a Hausdorff space, X, is minimal Hausdorff if and only if it is coinvariant; equivalently, if and only if every Hausdorff co-spcae of X equals X. This characterization of minimal Hausdorff spaces in terms of co-topology extends to other topological properties. Dissert. Abstr.

N68-19746* Santa Clara Univ., Calif.
SINGULAR LINES IN THE PARAMETER PLANE
D. J. Bowie (Roy. Can. Navy) and G. J. Thaler (Naval Postgraduate School) 1968 6 p
(Grant NGR-05-017-010)
(NASA-CR-73204) CFSTI: $3.00 CSCL 12A

In Parameter Plane Theory certain conditions give rise to singular values. These singular values frequently define lines on the parameter plane, such that an infinite number of parameter combinations provide the system with a specific pair of complex roots. Rules are provided for predicting the existence of singular lines and for developing their equations. Illustrations and applications are included. Author

N68-19755 Pennsylvania Univ., Philadelphia.
COMPOUND DECISION THEORY AND DISCRETE TIME MARKOV PROCESSES
James F. Korsh (Ph.D. Thesis) 1966 77 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-7851

In this study, we compare the Bayes risks of various decision schemas for large n when the (ω_i, X_i) process is stationary. We show that if each decision is based on all n observations, then the Bayes risks decrease monotonically as n increases. However, a decision function which bases the i^{th} decision on a fixed number, c, of preceding observations, and a fixed number, d, of succeeding observations, will do essentially as well for proper choice of c and d, when n is large. Similarly, when each decision is based on all preceding observations, the Bayes risks decrease monotonically with n. Again a decision function which bases the i^{th} decision on a fixed number, c, of preceding observations will do essentially as well for proper choice of c, when n is large. To compute the Bayes solutions for any of the above decision schemes the a priori probability distribution of the (ω_i) process must be known. We derive a bound on the rate of convergence of the average risk of the "estimated" Bayes solution to the Bayes risk $\rho_n(p, H_0^n)$ when the (ω_i) process is a stationary ergodic Markov chain. Dissert. Abstr.

N68-19759 Minnesota Univ., Minneapolis.
ON THE ASYMPTOTIC THEORY OF TESTS OF INDEPENDENCE BASED ON BIVARIATE LAYER RANKS
George Gordon Woodworth (Ph.D. Thesis) 1966 89 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8064

We consider a class of tests based on linear combinations of layer statistics (layer tests). This class is a subclass of the class of layer-rank tests and contains the well-known Kendell's τ-test. We show that the problem of finding the layer test with maximum PARE with respect to the likelihood ratio test is equivalent to solving a certain integral equation and the solution is explicitly obtained. Dissert. Abstr.

N68-19770 Louisana State Univ., Baton Rouge.
ON HOMEOMORPHISMS OF INFINITE DIMENSIONAL PRODUCT SPACES
Raymond Yen-tin Wong (Ph.D. Thesis) 1966 40 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-1200

All spaces are assumed to be separable metric. By a homeomorphism on a space X (= self-homeomorphism) is meant a homeomorphism of X onto itself. By X^∞ is meant the infinite product space $\Pi_{i=1}^{\infty} X_i$ where $X_i = X$. A space X satisfies property ϕ if the homeomorphism g on X^∞ defined by $g(x_1, x_2, x_3, x_4, \ldots) = (x_2, x_1, x_3, x_4, \ldots)$ is isotopic to the identity mapping. *Theorem* 2.1. A necessary and sufficient condition that each homeomorphism

on X^{∞} is isotopic to the identity mapping is that X satisfy property ϕ. The following two theorems follow easily from *Theorem* 2.1. *Theorem* 2.2 (*Theorem* 2.3). Any homeomorphism on the Hilbert cube I^{∞} (on I^{∞}) is isotopic to the identity mapping. From *Theorem* 2.3 and the principal result of [2], asserting that the Hilbert space X_2 is homoeomorphic with I^{∞}, we have *Theorem* 2.4. Any homeomorphism on X_2 is isotopic to the identity mapping. Dissert. Abstr.

N68-19796# Naval Weapons Lab., Dahlgren, Va.
A COMPUTER PROGRAM FOR THE KOLMOGOROV GOODNESS OF FIT TEST FOR NORMALITY
Carl B. Bates and Jacqueline R. Orsulak Jan. 1968 54 p refs
(NWL-K-2/68; AD-665291)

Following a brief discussion on the background, applicability, and limitations of the Kolmogorov Test, a computer program of the Kolmogorov Test for normality is described. The program is applicable for testing the null hypothesis that a random sample is from a parent normal population whose mean and variance are equal to those of the sample distribution. The program determines the minimum and maximum sample values, computes sample estimates of the mean and variance of the hypothesized normal distribution, and computes the Kolmogorov statistic. Five optional significance levels (0.20, 0.15, 0.10, 0.05, and 0.01) are available, and sample size limitations are $4 < or = n < or = 2500$. An optional feature provides for CRT plot output applicable for both hypothesis testing and interval estimation. The program is coded in FORTRAN IV for the IBM 7030 (STRETCH) computer. Author (TAB)

N68-19856*# California Univ., Los Angeles. Dept. of Engineering.
FUNCTIONAL ANALYTIC ANALYSIS OF THE PURSUIT PROBLEM OF KELENDZERIDZE
Rahul Chattopadhyay Mar. 1968 28 p refs
Grant NsG-237-62)
(NASA-CR-93739; Rept.-68-6) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Some new applications of the theory of moments are described, and applications to linear control systems and the use of nonlinear programming for the basic maximization problem are considered. The assumptions made by Kelendzeridze related to optimal pursuit are analyzed, the concept of interceptibility is introduced and its conditions developed, and an estimate is provided for the set of initial states of the pursuer from which interception is possible. Concepts of optimal pursuit time and optimal strategies of pursuit are defined and methods for their presentation are included. M.W.R.

N68-19903# California Univ., Berkeley. Operations Research Center.
SELECTION PROCEDURES FOR RESTRICTED FAMILIES OF PROBABILITY DISTRIBUTIONS
Richard E. Barlow and Shanti S. Gupta (Purdue Univ.) Sep. 1967 38 p refs
(Contracts Nonr-3656(18); Nonr-1100(26))
(ORC-67-10; AD-664950)

The paper is primarily concerned with selecting a subset of k populations such that the probability is at least P star that the selected subset includes the population with the largest (smallest) quantile of a given order alpha ($0 < alpha < 1$). In particular a procedure is proposed and studied which is valid for any family of distributions with increasing failure rate on the average (IFRA). It is compared, asymptotically, with a distribution-free procedure proposed by Rizvi and Sobel. Author (TAB)

N68-19917# California Univ., Berkeley. Operations Research Center.
ON CONVEXITY PRESERVING FAMILIES OF PROBABILITY DISTRIBUTIONS
Willem R. van Zwet Sep. 1967 24 p refs
(Contract Nonr-3656(18))
(ORC-67-36; AD-664951)

Convexity preserving properties of certain totally positive density functions are shown to hold under weaker restrictions. These results generalize work of Karlin (1963) and Karlin and Proschan (1960) concerning convexity preserving transformations. Author (TAB)

N68-20000# RAND Corp., Santa Monica, Calif.
BOTTLENECK EXTREMA
Jack Edmonds and D. R. Fulkerson Jan. 1968 24 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5375-PR; AD-664879)

Bottleneck problems relate to matching input flow with production flow in order to optimize production. In this study, bottleneck extremum problems are established in their proper abstract setting, and a threshold method for their solution is found. Several examples of blocking systems are also discussed. Author (TAB)

N68-20001# RAND Corp., Santa Monica, Calif.
ON SOLUTIONS FOR N-PERSON GAMES
William F. Lucas Jan. 1968 21 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5567-PR; AD-664886)

A solution concept for n-person cooperative games in characteristic function form was introduced by von Neumann and Morgenstern in 1944. This study reviews the definitions of an n-person game and then describes two games whose sets of solutions are rather restricted. The first is a five-person game which has a unique solution that is nonconvex. The second is an eight-person game that has no solution possessing the symmetry of the characteristic function. Author (TAB)

N68-20015# Cornell Univ., Ithaca, N. Y. Dept. of Operations Research.
SOME LADDER PROCESSES IN CONTINUOUS TIME WITH APPLICATION TO QUEUES
Frank M. Worthington Nov. 1967 84 p refs
(Contract Nonr-401(55))
(TR-34; AD-664678)

Ladder processes are constructed for a basic stochastic process in continuous time with discrete state space. These processes are used to obtain limit theorems for the supremum and infimum functionals defined on this basic process. Application of these results to queues with Poisson arrivals and general Erlangian type service time density are then discussed in the case where no steady state exists, that is, where the traffic intensity is greater than or equal to one. Author (TAB)

N68-20048 Syracuse Univ., N. Y.
PERIODIC SYSTEMS OF THE PERTURBATION TYPE: SMALL PARAMETER BOUNDS
Stephen George Dick (Ph.D. Thesis) 1968 190 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-7069

In this dissertation bounds on the small parameter of systems of the perturbation type are developed to insure existence of periodic solutions. Solutions sought are in K, the space of functions which are periodic in time, t, of period T and are Lebesque square integrable over a period. The procedure follows the general framework of the Hale–Cesari technique. A projection operator, suitably defined on K, is used to decompose the problem into two parts, an associated equation and a bifurcation equation. Iteration procedures are developed for both the associated equation and the bifurcation equation. The tools of functional analysis and, in particular, the Contraction Mapping Fixed Point Theorem are used to establish bounds on the small parameter, β, to insure the

convergence of each of the iteration procedures. The smaller of the two bounds obtained is recognized as the value which insures solution to the overall system. Dissert. Abstr.

N68-20051*# Tennessee Univ., Knoxville. Dept. of Electrical Engineering.
DESIGN OF LOW SENSITIVITY SAMPLED DATA CONTROL SYSTEMS
J. C. Hung and J. E. Bennett 21 Feb. 1968 19 p refs
(Grant NsG-351)
(NASA-CR-93781; SR-17) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A frequency domain technique is developed for designing the minimum sensitivity deadbeat sampled-data control systems where plant variations are encountered. This is done by modifying a previously proposed design technique for minimal sensitivity systems. The definitions of minimal sensitivity, minimum sensitivity, and deadbeat property are defined. The present method is to reduce the magnitude of the output variation, due to plant variations, by using two controllers. Two examples are given to demonstrate the effectiveness of the method. In general, the magnitude of the output variation for the minimum sensitivity system is smaller than that for the minimal sensitivity system. But both systems are less sensitive to plant variation than the single controller system. Author

N68-20202# Royal Aircraft Establishment, Farnborough (England).
THE DIAGONALISATION OF A CERTAIN COVARIANCE MATRIX
P. W. James Sep. 1967 15 p ref
(RAE-TR-67239; AD-664842)

The eigenvalues of the N x N matrix are derived for arbitrary N. TAB

N68-20205# California Univ., Los Angeles.
AN APPLICATION OF NEWTON'S METHOD TO THE EULER-LAGRANGE EQUATION
Richard A. Tapia [1967] 27 p refs
(Contract Nonr-233(76))
(AD-665005)

The theory developed in the report can be used to solve the generalized Euler-Lagrange equation. TAB

N68-20209 Minnesota Univ., Minneapolis.
INTEGRATION ON CERTAIN SPACES OF CONTINUOUS FUNCTIONS
Jean Thurber Sells (Ph.D. Thesis) 1966 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-7783

A theorem is proved showing the transformation undergone by the integral of any measurable functional F(y) when $y(t) = x(t) + x_0(t)$, for $x_0(t)$ in C(a,b) and satisfying certain conditions. A complete orthonormal set of functionals on C(a,b) is defined so that every real or complex-valued functional F(x) which belongs to $L_2[C(a,b)]$ has a Fourier development in terms of this set which converges in the $L_2[C(a,b)]$ sense to F. Finally, it is shown that for $a < b < c$, $\int_{C(a,c)} F(x)dx = \int_{C(a,b)} \times C(b,c)\, F(y+z)d(y \times z)$ whenever the left-hand side exists. Properties are proved for the integral over C(a,b,c,d) corresponding to most of the properties proved for the integral on C(a,b). Dissert. Abstr.

N68-20211# New York Univ., N. Y. Courant Inst. of Mathematical Sciences.
MINIMAX LINEAR PREDICTOR UNDER LIPSCHITZ' TYPE CONDITIONS FOR THE REGRESSION FUNCTION
Kei Takeuchi Jan. 1968 39 p
(Contract Nonr-285(38))
(IMM-363; AD-665279)

Regression analysis is one of the most popular and most often used techniques in various fields of statistical data analysis. In some cases, however, regression analysis is very dangerous, and sometimes gives awkward results. Such dangers, which are inherent in regression techniques, are well known, at least well perceived by experienced applied statisticians. But theoretical analysis of such a situation that yields some pitfalls to the careless application of regression analysis is far from satisfactory. Though well trained statisticians can evade such a danger by their good judgment, there is no formal well established technique that may be applied. The purpose of this paper is to derive some method to treat one such difficulty, i.e. the problem of the functional form of the regression. TAB

N68-20225*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OPTIMIZED COMPUTATION WITH RECURSIVE POWER SERIES INTEGRATION
R. H. Estes and E. R. Lancaster Mar. 1968 13 p refs
(NASA-TM-X-63148; X-643-68-80) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The power series technique is applied to the restricted three-body problem and recursion formulas are developed for the coefficients of the power series which reduce significantly the computation time required by the recursion formulas developed by previous authors. Van Flandern's method for maximizing the step size per unit of computer time is discussed and extended on the basis of relative error control. A method for controlling the magnitudes of the series coefficients is also presented. Author

N68-20229# Yale Univ., New Haven, Conn. Dept. of Engineering and Applied Science.
ON A CLASS OF FINITE STOCHASTIC GAMES. PART 1: THEORY
G. R. Mon Feb. 1968 29 p refs
(CT-19, Pt. 1)

The basic theory of a class of zero-sum two-person (P and E) discrete stochastic game problems is developed. The state transition process is assumed to be Markovian and to be governed by a difference equation. The players attempt to minimize the expected value of a pay off functional by choosing an optimal pair of stochastic strategies, namely, the saddle point strategies of the pay off functional. Necessary conditions for the optimality of a pair of stochastic strategies are derived. It is shown that optimal strategies, in general, are of a specific type, termed hybrid. Author

N68-20249# Carnegie-Mellon Univ., Pittsburg, Pa. Management Sciences Research Group.
ON THE NUMERICAL CLASSIFICATION OF NOMINAL DATA
Giandomenico Majone and Peggy R. Sanday Jan. 1968 35 p refs
(Contract Nonr-760(24))
(RR-118; AD-665006)

A method of classification of qualitative data, based on a non-Euclidean metric, is proposed here. A set-theoretic formulation of some taxonomic problems is given. Relations to general problems of numerical taxonomy are discussed. The method is applied to the analysis of anthropoligical data. Author (TAB)

N68-20254# Harvard Univ., Cambridge, Mass. Statistics Dept.
A GENERALIZATION OF BAYESIAN INFERENCE
Arthur P. Dempster 15 Nov. 1967 73 p refs
(Contract Nonr-1866(37))
(TR-20; AD-664659)

Procedures of statistical inference are described which generalize Bayesian inference in specific ways. probability is used in such

a way that in general only bounds may be placed on the probabilities of given events, and probability systems of this kind are suggested both for sample information and for prior information. These systems are then combined using a specified rule. Illustrations are given for inferences about trinomial probabilities, and for inferences about a monotone sequence of binomial p sub i. Finally, some comments are made on the general class of models which produce upper and lower probabilities, and on the specific models which underlie the suggested inference procedures. Author (TAB)

N68-20284# Naval Missile Center, Point Mugu, Calif.
A DECISION THEORY APPROACH TO ACCEPTANCE TESTING
E. D. Simmons and C. E. Wisler 31 Jan. 1968 36 p refs
(NMC-TM-67-77; AD-665029)

The report discusses the application of statistical decision theory to the problem of acceptance testing by attributes. The classical approach to acceptance testing is introduced and discussed so that it may be contrasted with the decision theory approach. The decision theory approach, which attempts to find an optimal trade-off between the expected costs of wrong decisions and sampling costs, is illustrated by an example using the Bayesian statistical viewpoint. In the example, sample size is assumed to be predetermined and the problem is to select the optimal action based upon prior knowledge and the results of the sample inspection. The problem is then broadened to include the trade-off between the costs of wrong decisions and the costs of sampling inspection. A numerical example is solved via a simple computer program to illustrate the results of the analysis. A survey of the literature dealing with the application of decision theory to acceptance testing is presented, the contents of the report discussed, and suggestions for further work made. Author (TAB)

N68-20326 Lehigh Univ., Bethlehem, Pa.
A FINITE DIFFERENCE SCHEME FOR A THIRD BOUNDARY VALUE PROBLEM
Zafarullah (Ph.D. Thesis) 1966 65 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-4881

A finite difference scheme for the solution of an elliptic boundary value problem of two variables with natural boundary condition is described. The salient feature of this scheme is that the coefficients of the difference equations at points near the boundary depend on areas of certain segments of the region and do not directly depend on the normal vector at the boundary. The pointwise convergence of the solution of the system of difference equations to the actual solution of the given boundary value problem is treated. The proof of convergence is based on the use of maximum principle. This section also contains an application of the finite difference scheme. Though the present finite difference scheme has been developed for a two dimensional elliptic boundary value problem, the method adopted is quite general and can be applied to similar problems with more than two variables. Dissert. Abstr.

N68-20371*# Florida State Univ., Tallahassee.
THE LIMITING DISTRIBUTION OF THE LIKELIHOOD RATIO STATISTIC $-2\ln\lambda_n$ UNDER A CLASS OF LOCAL ALTERNATIVES. PART 1. MINUMUM AVERAGE RISK DECISION PROCEDURES FOR THE NONCENTRAL CHI-SQUARE DISTRIBUTION, PART 2
William Edwin Lever (Ph.D. Thesis) Jan. 1968 150 p refs
(Grants NGR-10-004-029; NIH 5-1-GM-913; Contract Nonr-988(08))
(NASA-CR-93817) CFSTI: HC $3.00/MF $0.65 CSCL 12A

CONTENTS:

1. THE LIMITING DISTRIBUTION OF THE LIKELIHOOD RATIO STATISTIC $-2\ln\lambda_n$ UNDER A CLASS OF LOCAL ALTERNATIVES W. E. Lever p 1–56 (See N68-20372 10-19)

2. MINIMUM AVERAGE RISK DECISION PROCEDURES FOR THE NONCENTRAL CHI-SQUARE DISTRIBUTION W. E. Lever p 57–122 (See N68-20373 10-19)

N68-20372*# Florida State Univ., Tallahassee.
THE LIMITING DISTRIBUTION OF THE LIKELIHOOD RATIO STATISTIC $-2\ln\lambda_n$ UNDER A CLASS OF LOCAL ALTERNATIVES, PART 1
William Edwin Lever *In its* The Limiting Distribution of the Likelihood Ratio Statistic $-2\ln\lambda_n$ Under a Class of Local Alternatives, Pt. 1. Minimum Average Risk Decision Procedures for the Noncentral Chi-Square Distribution, Pt. 2 Jan. 1968 p 1–56 (See N68-20371 10-19)

Maximum likelihood properties and asymptotic distributions are covered in this first part of thesis that offers proof that the likelihood ratio statistic $-2\ln\lambda_n$ converges in distribution, not necessarily uniformly, to a noncentral chi-square distribution under local alternatives to the null hypothesis. Consideration is limited to the maximum likelihood estimates that are solutions to the likelihood equations obtained for the maximization processes. Asymptotic properties of the null and non-null maximum likelihood estimators are discussed. Proof of the basic theorem is detailed, and sampling from associated populations as well as transformations in the parameter space are discussed. M.W.R.

N68-20373*# Florida State Univ., Tallahassee.
MINIMUM AVERAGE RISK DECISION PROCEDURES FOR THE NONCENTRAL CHI-SQUARE DISTRIBUTION, PART 2
William Edwin Lever *In its* The Limiting Distribution of the Likelihood Ratio Statistic $-2\ln\lambda_n$ under a Class of Local Alternatives, Pt. 1. Minimum Average Risk Decision Procedures for the Noncentral Chi-Square Distribution, Pt. 2 Jan. 1968 p 57–122 (See N68-20371 10-19)

Possible methods are presented for making decisions about the unknown noncentrality parameters of noncentral chi-square distributions, assuming that the noncentrality parameters are random variables with continuous distributions. A two-decision procedure is delineated; and extensions are offered that involve (1) a combination of p two-decision procedures on the magnitudes of the noncentrality parameters and (2) a q-decision procedure based on one noncentrality parameter. Aids included for use with the developed decision procedures assume a gamma prior distribution for the noncentrality parameter. Tables give the critical values needed to conduct the decision procedure, as well as a set of values from which new posterior parameters can be approximated by using a gamma distribution. To use these tables, it must be assumed that the loss functions are linear in the noncentrality parameter and zero when a true decision is made. An approximate method for determining optimal sample size for each decision procedure is included. M.W.R.

N68-20456# Princeton Univ., N. J.
A PROBABILISTIC APPROACH TO THE PARAMETER SENSITIVITY PROBLEM
B. Liu and M. E. van Valkenburg 1967 12 p refs Presented at the 5th Ann. Allerton Conf. on Circuit and System Theory, Allerton, England, 4–6 Oct. 1967 Submitted for publication
(Grants AF-AFOSR-1333-67; NSF GK-1439)
(AFOSR-68-0327; AD-665874)

The deviation of a system function from its nominal value due to random variations or the inherent uncertainty of the system parameters is examined. Bounds on various probabilistic measures of this deviation are discussed and examples are given. A comparison is made with the deterministic multiparameters sensitivity function. Author (TAB)

N68-20485# Purdue Univ., Lafayette, Ind. Statistics Dept.
A WORKING BIBLIOGRAPHY ON MARKOV RENEWAL PROCESSES AND THEIR APPLICATIONS

Marcel F. Neuts Feb. 1968 26 p refs *Its* Mimeograph Ser. No. 140
(Contract Nonr-1100(26))
(AD-665778)

The report contains an exhaustive list of references in the theory of Markov renewal processes, semi-Markov processes and their applications. Both published papers and technical reports have been listed. Author (TAB)

N68-20486 Duke Univ., Durham, N. C.
COVERING DIMENSION AND METRIC-DEPENDENT DIMENSION FUNCTIONS
James Burton Wilkinson (Ph.D. Thesis) 1966 32 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-6874

The main result of this dissertation can be stated as follows: Theorem: *Let X be a topological space, and let m be an integer not less than* -1; *let* $A_1A_2 \ldots$ *be a countable collection of closed subsets of X such that* $\dim(A_i \cap A_j) \leq m$ *whenever* $i \neq j$. *Then* $\dim(X - \bigcup_{i=1}^{\infty} A_i) \geq n-m-2$ *if one of the following two sets of conditions is satisfied:* 1) X *is compact Hausdorff,* $X - \bigcup_{i=1}^{\infty} A_i$ *is normal,* $\dim(X) \geq n \geq 1$, *and* $\dim(A_i) \leq n-1$ *for every natural number* i. 2) X *is an n-dimensional manifold.* The standard characterizations of covering dimension are shown to characterize various metric-dependent dimension functions if attention is restricted to uniformly continuous functions and covers with Lebesgue numbers. A locally finite sum theorem is proved for metric dimension. Dissert. Abstr.

N68-20479# International Centre for Theoretical Physics, Trieste (Italy).
LOCALIZED STATES AND GROUP CONTRACTION IN 4+2 DE SITTER SPACE
Awele Maduemezia Mar. 1967 22 p refs Submitted for publication
(IC/67/13) CFSTI: HC $3.00/MF $0.65

A detailed study is made of the problem of imbedding space–time in 4+2 de Sitter space. It is shown that such an imbedding invariably leads to a contraction of the group O(4,2) and to a restriction of the Poincare A2 group operations to a space-like surface in space–time. Localized particle states are constructed as normalizable eigenfunctions of the mass-squared operator. Explicit expressions for relativistic position operators are derived from the contraction of the algebra of the group O(4,2) induced by a certain limit-taking involved in the space–time imbedding process. Author (ESRO)

N68-20537 Purdue Univ., Lafayette, Ind.
A QUADRATICALLY CONVERGENT METHOD FOR SOLVING SIMULTANEOUS NON LINEAR EQUATIONS
Kenneth Myron Brown (Ph.D. Thesis) 1966 66 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-5422

An iterative method for the numerical solution of a system of N simultaneous non-linear algebraic equations is presented. A proof of local convergence for the method is given in which it is shown that the convergence is quadratic in nature. Computable bounds on the region of convergence are obtained in connection with a non-local convergence theorem. Computer results for specific applications of the method are given and comparisons are made with other currently used methods. In particular it is shown that the method requires only $(N^2/2 + 3N/2)$ function evaluations per iterative step as compared with $(N^2 + N)$ evaluations for Newton's Method. An ALGOL procedure for the method is also given. Dissert. Abstr.

N68-20638 Illinois Univ., Urbana.
ON HOMOGENEOUS DIAGONAL CONGRUENCES OF ODD DEGREE
Karl Kenneth Norton (Ph.D. Thesis) 1966 177 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-6692

Small Latin letters other than e denote integers. For each $k>0$, define $\Gamma^*(k)$ to be the smallest s with the following property: for each prime p, each $h>0$, and any $c_1,\ldots,c_s$ the congruence $c_1x_1^k+\ldots+c_sx_s^k \equiv 0 \pmod{p^h}$ has a solution in which $x_1, \ldots, x_s$ are not all divisible by p. Let $\sigma = \limsup |\Gamma^*(k)(k\log k)^{-1}|$, where the lim sup is taken over odd k tending to $+\infty$. Our main result is that $\sigma \leq 3/\log 4$. The proof of this depends on various elaborations of the Chowla–Shimura method, some basic results due to Davenport and Lewis, and some new upper estimates for the smallest positive representatives of the various cosets of $H_k(p^w)$ (the subgroup of k^{th} powers in the coprime residue-class group modulo p^w, where p is an odd prime). Dissert. Abstr.

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N68-19497# Grace (W. R.) and Co., Cambridge, Mass. Chemical Div.
A STUDY OF THE THEORETICAL AND PRACTICAL ASPECTS OF ASCENT RATE IN METEOROLOGICAL HIGH ALTITUDE BALLOON SOUNDINGS Final Report
Jun. 1967 207 p refs
(Contract CWB-11369)
(PB-176243) CFSTI: HC $3.00/MF $0.65

The report, by fitting performance of various balloon designs and their associated costs to the minimum angles each would subtend at 14 km, contains a measure of cost vs. performance and reliability from which the Weather Bureau may choose one or more balloon systems as targets of future development. Author

N68-19498# California Univ., Los Angeles. Dept. of Meteorology.
SATELLITE STUDIES OF CLOUDS AND CLOUD BANDS NEAR THE LOW LEVEL JET Final Report
William D. Bonner and Frank Winninghoff Sep. 1967 46 p refs
(Contract CWB-11210; Grant NSF GA-698)
(PB-176511) CFSTI: HC $3.00/MF $0.65

TIROS 7 and 8 photographs are used to study synoptic and mesoscale cloud patterns during six days with strong southerly flow in the central United States. Cases with nocturnal thunderstorms show a tendency for thunderstorms to occur in a downstream portion of the jet. Through advection of moisture and turbulent breakdown of the nocturnal inversion the low-level jet plays an important role both in the formation of stratus and in its manner of dissipation. Longitudinal cumulus cloud bands with spacing of 10 to 15 km occur with slightly superadiabatic lapse rates and moderate wind shear in agreement with theoretical results by Kuo. Author

N68-19500# National Center for Atmospheric Research, Boulder, Colo.
PROJECT CLAMBAKE: SURFACE WIND ANALYSIS AT PALESTINE, TEXAS
H. W. Baynton Nov. 1967 43 p refs
(NCAR-TN-33; PB-176530) CFSTI: HC $3.00/MF $0.65

A clam-shaped inflation shelter was proposed for use during launching of large balloons when wind speed exceeds 10 kt. Full use of such a shelter would depend on forecasts of wind lulls lasting up to 10 min. Such forecasts would be feasible if the existence of coherent eddies in the size range 0.5 to 6 mi could be verified. To determine if such eddies exist, the Field Observing Facility of

the National Center for Atmospheric Research measured surface winds at 13 locations within 5 mi of the NCAR Scientific Balloon Flight Station at Palestine, Texas during October and November 1965. Analysis of 102 hr of data collected on 12 days uncovered no evidence of a coherent eddy structure in the required size range. Thus no means of forecasting occasional lulls at the balloon base were apparent. Wind bursts associated with cloudless cold fronts did appear to be predictable from a network of wind stations. Author (TAB)

N68-19508# Allied Research Associates, Inc., Concord, Mass.
A STUDY OF DYNAMICAL RELATIONSHIPS BETWEEN CLOUD PATTERNS AND EXTRATROPICAL CYCLOGENESIS Final Report
C. William Rogers and Paul E. Sherr Sep. 1967 80 p refs
(Contract E-47-67(N))
(ARA-8G37-F; PB-176518) CFSTI: HC$3.00/MF$0.65

Presumed unique dynamical relationships between the development stages of low-level baroclinic cyclones and the satellite observed concurrent cloud patterns were studied. The study was based on a hypothesis on the relative roles of vertical motion and of horizontal cloud advection in the formation of the vortical cloud patterns associated with extratropical cyclones. This hypothesis was tested for one developing cyclone sequence through computation of quasi-geostrophic vertical motions (including their partition into components due to vorticity and to thermal advection) and three-dimensional air parcel trajectories. The basic hypothesis is that, the observed cloud patterns result principally from characteristic patterns of vertical motion during the earlier stages of storm development. In later stages, horizontal advection of the previously formed cloud masses becomes progressively more important in shaping the cloud field, especially as closed circulations develop at higher levels. In general, the computed vertical motions verified the hypothesis. It was found, however, that cloud-forming upward vertical motions persist longer in the western portion of systems than had been anticipated. Vertical motions due to thermal advection play a greater role, especially at low levels, than had been expected. Accordingly, analyses of the component vertical motion fields were essential to understanding the dycal realtionships. Author

N68-19509# Environmental Science Services Administration, Silver Spring, Md.
BIBLIOGRAPHY ON THE CLIMATE OF CHILE
1967 22 p refs
(WB/BC-12; PB-176732) CFSTI: HC$3.00/MF$0.65
A bibliography of 58 references is given. TAB

N68-19518# Massachusetts Inst. of Tech., Cambridge.
AN INVESTIGATION OF LARGE SCALE HEAT TRANSFER PROCESSES AND SEA SURFACE TEMPERATURE FLUCTUATIONS IN THE NORTH PACIFIC OCEAN
Nathan Edward Clark (Ph.D. Thesis) 12 May 1967 281 p refs Sponsored in part by the Weather Bur.
(Grant NSF G-24832)
(PB-176578) CFSTI: HC$3.00/MF$0.65

The atmospheric and oceanic parameters of sea-surface temperature, air temperature, wet-bulb temperature, cloud cover, and wind speed are used to compute monthly average values of the incoming radiation, the effective back radiation, the latent and sensible heat transfers, and the total heat transfer across the sea surface over the North Pacific Ocean from 20N to 55N for the period extending from 1951 through 1957. Author (TAB)

N68-19565# Environmental Science Services Administration, Silver Spring, Md.
SECONDARY BIBLIOGRAPHY ON THE CLIMATE OF VENEZUELA
1967 13 p refs
(WB/BC-27; PB-176745) CFSTI: HC$3.00/MF$0.65
A bibliography of 51 references is given. TAB

N68-19679# Koninklijk Nederlands Meteorologisch Instituut, Rotterdam (Netherlands).
OBSERVATION AND ANALYSIS OF THE SURFACE WIND OVER THE OCEAN
G. Verploegh The Hague Staatsdrukkerij 1967 60 p refs
(Rept.-89) CFSTI: HC$3.00/MF$0.65

A theory is developed for constructing the Beaufort Scale as given by its equivalent wind speeds. It is postulated that what is primarily observed is the distribution of gusts in space, or the gust frequency in time. Such observations lead to the evaluation of a wind force which is directly proportional to the wind speed. The postulate was verified on the basis of two independently developed wind scales, and an empirical rule is evolved. The rule states that whatever wind effects are observed the same wind scale will evolve. Possible errors of observation, relating to the kind of wind effects observed, the spacing of the scale intervals, and the nonlinearity of the scale of equivalent speeds are discussed. The reliability of wind measurements made routinely on board ship is examined, and a method is indicated whereby the reliability of the measured relative wind on different ships can be compared with the help of estimated winds as a common reference. The extent to which a single wind observation may represent the average wind speed over a sea area of 60 miles in diameter is also discussed. E.J.S.

N68-19753*# Scripta Technica, Inc., Washington, D. C.
INVESTIGATION OF METEOROLOGICAL AND IONOSPHERIC CONDITIONS OF THE OCCURRENCE OF NOCTILUCENT CLOUDS IN SIBERIA [K IZUCHENIYU METEOROLOGICHESKIKH I IONOSFERNYKH USLOVIY POYAVLENIYA SEREBRISTYKH OBLAKOV S SIBIRI]
N. N. Fast Washington NASA Mar. 1968 6 p refs Transl. into ENGLISH from Meteorol. Issled. (Moscow), no. 12, 1966 p 106–110
(Contract NASw-1694)
(NASA-TT-F-11525) CFSTI: HC$3.00/MF$0.65 CSCL 04B

The paper considers the question of the connection of noctilucent clouds with the synoptical conditions in the light of the conclusions. The author could not draw any regularity in synoptical conditions prior to the noctilucent cloud appearance. The paper gives a statistical estimation of the hypothesis about the existence of the connection between the noctilucent cloud appearance and the height of the sporadic ionospheric layer E. There are no sufficient factual data to correct the hypothesis. Author

N68-19772# Koninklijk Nederlands Meteorologisch Instituut, The Hague.
CLIMATOLOGY OF AMSTERDAM AIRPORT (SCHIPHOL)
Staatsdrukkerij 1966 145 p
(Rept.-87) CFSTI: HC$3.00/MF$0.65

Aeronautical data concerning the climatology in the vicinity of the Schiphol airport at Amsterdam are presented in a series of tables based on hourly observations made between January 1, 1949, and December 31, 1963. Basic data are provided on horizontal visibility and cloud base height, duration of fog, surface wind, temperature and pressure, relative humidity, and precipitation. Additional data are presented on visibility and wind condition data prior to January 1, 1949. M.W.R.

N68-19773# Weather Bureau, Washington, D. C. Weather Analysis and Prediction Div.
RECENT TRENDS IN THE ACCURACY AND QUALITY OF WEATHER BUREAU FORECASTING SERVICE

Charles F. Roberts and John M. Porter Nov. 1967 17 p
(WBTM-FCST-8; PB-176953) CFSTI: HC $3.00/MF $0.65

For many years the Weather Bureau has computed the percent correct index for both precipitation and temperature for selected stations. For the past nine years detailed records of forecast accuracy for these two weather elements have been compiled for all stations issuing local weather forecasts. The changes in forecast accuracy during this period are shown. These data show some improvement in accuracy of precipitation forecasting during the last four years in the forecasts for 'tonight' and 'tomorrow'. The forecast of the weather for 'today' has not changed noticeably during the period. Author

N68-19865# Koninklijk Nederlands Meteorologisch Instituut, The Hague.
THE SOUTHERN OSCILLATION AND WORLD WEATHER [DE ZUIDELIJKE SCHOMMELING EN HAAR MONDIALE UITBREIDING]
H. P. Berlage 1966 148 p refs
(Rept.-88) CFSTI: HC $3.00/MF $0.65

Southern Oscillations (SO) observed in the East Indies and Indonesia, were analyzed and related to meteorological and oceanographic data from other parts of the world. The SO, a fluctuation of the intensity of the intertropical general atmospheric and hydrospheric circulation, is spontaneously generated and dominated by exchange of air between the Southeast Pacific subtropical high and the Indonesian equatorial low. Its period averages 30 months and varies between 1 and 5 years; and a standard type SO of wavelength 3 years was developed that shows almost global extension. The South American meridonial mountain barrier is one of the major fronts directing SO operations. Relations to arctic conditions are dominated by a North American Oscillation, which is probably the only self-sustaining oscillation besides the SO; while relations to antarctic conditions are restricted to incidental cases of blocking of the strong southwesterly circulation by pressure ridges between Antarctica and the Southern Pacific high. No plain relations were traced between the SO and the quasi-biennial fluctuation of the equatorial stratospheric winds. M.W.R.

N68-19964# Weather Bureau, Washington, D. C. Office of Hydrology.
ANNOTATED BIBLIOGRAPHY OF ESSA PUBLICATION OF HYDROMETEOROLOGICAL INTEREST
J. L. H. Paulhus Nov. 1967 31 p refs 2d ed.
(WBTM/HYDRO-6; PB-177042) CFSTI: HC $3.00/MF $0.65

The bibliography is especially intended to serve the engineer by bringing to his attention the publications of hydrometeorological material and he often requires. Some of the publications listed are included also in other indices covering meteorological or climatological subjects. Author

N68-19975# Weather Bureau, Silver Spring, Md. Weather Analysis and Prediction Div.
REPORT ON THE FORECAST PERFORMANCE OF SELECTED WEATHER BUREAU OFFICES OF 1966–1967
C. F. Roberts, J. M. Porters, and G. F. Cobb Dec. 1967 56 p refs
(WBTM/FCST-9; PB-177043) CFSTI: HC $3.00/MF $0.65

Contents: The Problem of Evaluating Forecast Performance; The Current Forecast Verification Program in the Weather Bureau; (Area forecast center, local forecast verification, summary forecast verification); Analysis of the Results for the Years 1966–1967; (Characteristics of precipitation forecast performance, temperature forecast performance). Author

N68-20109# Arizona Univ., Tucson. Inst. of Atmospheric Physics.
TECHNICAL REPORTS ON METEOROLOGY AND CLIMATOLOGY OF ARID REGIONS: AN EVALUATION OF PRECIPITATION, VEGETATION AND RELATED FACTORS ON THE SANTA RITA EXPERIMENTAL RANGE
Christine R. Green and S. Clark Martin (Dept. of Agr.) Apr. 1967 89 p refs
(TR-17; PB-177135) CFSTI: HC $3.00/MF $0.65

Monthly and annual precipitation data for 45 rain gages over the Santa Rita Experimental Range are presented in this publication. A common 26-year period for 22 of the gages is used in statistical analyses. The results are tabulated and presented graphically. The effectiveness of precipitation on vegetation and soil moisture in the area is discussed. Tables and graphs depict the typical effects to be found within the Experimental Range. Author

N68-20185# Smithsonian Institution, Washington, D. C. Astrophysical Observatory.
AN ANALYSIS OF THE ATMOSPHERIC TRAJECTORIES OF 413 PRECISELY REDUCED PHOTOGRAPHIC METEORS, VOLUME 10, NUMBER 1
Luigi G. Jacchia (Harvard Coll. Obs., Cambridge, Mass.), Franco Verniani (Consiglio Nazl. delle Ric., Rome (Italy)), and Robert E. Briggs 1967 142 p refs
GPO: $1.00

Atmospheric trajectories of 413 precision-reduced meteors were statistically analyzed; and the dependence of their heights, lengths, durations, decelerations, and magnitudes on angle of incidence, mass, velocity, ablation coefficient and fragmentation was studied. Of these 413 meteors that were doubly photographed with Super-Schmidt cameras in New Mexico, only one is considered to be a meteor of asteroidal origin. Peculiarities of individual showers and meteors with abrupt beginnings are discussed. Numerous tables detail the results obtained. M.W.R.

N68-20234# Hebrew Univ., Jerusalem (Israel). Dept. of Meteorology.
METEOROLOGICAL SATELLITE DATA, PART 2 Final Report, Mar. 1966–Jun. 1967
J. Neumann Jul. 1967 37 p refs Prepared in cooperation with Israel Min. of Transport and Commun. Meteorol. Serv.
(Contract CWB-11055)
(PB-177066) CFSTI: HC $3.00/MF $0.65

Contents: Mountain lee waves in the Middle East: Theoretical calculations compared with satellite pictures. On the moisture sources of clouds connected with the subtropical jetstream in the Middle East. Author

N68-20341# Stanford Research Inst., Menlo Park, Calif.
DETECTION OF CLOUD DISPLACEMENT USING VIDEO TECHNIQUES Final Report
S. M. Serebreny, W. E. Evans, R. G. Hadfield, and E. J. Wiegman Sep. 1967 40 p
(Contract E-167-67(N))
(PB-176951) CFSTI: HC $3.00/MF $0.65

The potential value of obtaining records of cloud displacements through the use of a television display system is investigated. Requirements for an operational system are outlined. Photographic prints of the cloud data were scanned and stored on a magnetic disc from which recall of all or any portion of the cloud cover can be reproduced on the cathode ray tube. Conventional electronic systems were used. The display could be varied to include time-lapse effects, frame-to-frame differencing, color fringing, and magnification. Displacements for ten examples were derived using data from ATS-1. These evaluations included the following categories: (1) cumulus cells, (2) cloud masses, (3) frontal cloud bands, and (4) wispy cloud forms (cirrus). It was concluded that analysis of cloud displacements through this system is both feasible and advantageous. Future systems envisioned will incorporate the capability to measure and record the cloud motions objectively. Author

N68-20375*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
INVESTIGATION OF AIR-FLOW VELOCITY BY LASER BACKSCATTER
Kent R. Bourquin and Fred H. Shigemoto Washington Apr. 1968 23 p refs
(NASA-TN-D-4453) CFSTI: HC$3.00/MF$0.65 CSCL 04B

An investigation of laser light backscatter properties from an atmosphere emphasized the effect of frequency shift. The detection scheme described is based on this effect and proved successful in the laboratory determination of flow velocity of a contaminated atmosphere. The results agree well with measurements taken with a hot wire anemometer. This investigation used a continuous wave laser radiating in the visible region. The velocity of an air stream containing a small concentration of contaminants was measured. Using this technique to detect clear air turbulence would require that Mie scattering predominate in the turbulent region. This technique does not presently appear practical for airborne detection of clear air turbulence considering the available laser transmitters and detectors, and the uncertain knowledge of the contaminating particle content in a turbulent region. Author

N68-20519# Environmental Science Services Administration, Miami, Fla. National Hurricane Research Lab.
PROJECT ECCRO: A SYNOPTIC EXPERIMENT IN THE TROPICS
Toby N. Carlson Aug. 1967 38 p refs
(IERTM-NHRL-80; PB-176071) CFSTI: HC$3.00/MF$0.65

An intensive reconnaissance expedition, involving the use of multilevel aircraft flights and special radiosonde ascents, was carried out over the eastern Caribbean during a relatively quiescent period in October 1965. This paper contains, first, an outline of the type of instrumentation used and the methods applied in reducing, correcting, and analyzing the data. Next, sample analyses are presented for each of the five levels and for 1 of the 6 days of the project, showing the distribution of winds, geopotential heights, temperatures, mixing ratios, vertical velocities, and cloud patterns. Finally, a summary of the spatial variability of the various quantities is given with a discussion concerning the amount of uncertainty in the analyses. Author

N68-20520* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SUPPORT DATA FOR CONVAIR 990 METEOROLOGICAL FLIGHT 1
M. S. Tobin Jan. 1967 144 p
(NASA-TM-X-63132; X-622-67-32) CFSTI: $3.00 CSCL 04B

This document contains, as a function of time, the environment, position, and attitude of the Convair 990 aircraft during 41 meteorological flights. Also listed is information concerning coordination of the flights with Nimbus II overpasses and with flights of a Comanche aircraft, the types of flight patterns, brief descriptions of the flights, and maps of the flight tracks. Five experiments were aboard the aircraft during these flights. A medium resolution infrared radiometer measured electromagnetic radiation emitted and reflected from the earth and atmosphere in five selected bandwidths. A filter wedge spectrometer measured electromagnetic radiation in the region 1.5 to 5.4 microns. Two Yellott Sol-a-Meters measured albedo of the earth and atmosphere. A spherics experiment measured field strength of spherics from convective clouds at 10 MHz, 74 MHz, 610 MHz, and 9GHz. A polarimeter measured the polarization of reflected radiation from aerosols, other atmospheric constituents, and the surface below. R.N.A.

N68-20631 Joint Publications Research Service, Washington, D. C.
METEOROLOGY
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 177 3 Apr. 1968 p 7–44 refs (See N68-20529 10-13)

Several news items are reported relating to automatic processing of meteorological data, computer usage in climatology research, automatic weather station design and operation, measuring instrumentation and techniques, and weather modification methods. Abstracted data are presented on scientific articles pertaining to atmospheric circulation, vertical air currents, condensation nuclei, fog formation, hydromechanics, solar radiation, cloud physics, diurnal temperature variations, data processing, meteorological satellites, wind profiles, and precipitation. M.G.J.

N68-20568# School of Aerospace Medicine, Brooks AFB, Tex.
SPACE WEATHER FORECASTING
Ernest A. Pinson *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 396–400 (See N68-20545 10-04)

The Air Force weather service maintains a prediction system for solar proton showers in connection with solar sunspot cycle observations. Solar proton showers with energy fluxes of several million electron volts constitute a hazard for technical devices and instrumentation in space flight. They can be predicted by observation of rapid changes in the sunspots themselves, the presence of highly structured magnetic fields with steep gradients and a mixture of opposite polarities, the frequent occurence of small looped flares and surge prominences, and the emission of certain types of radio bursts. G.G.

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N68-19702# Wilcox Electric Co., Inc., Kansas City, Mo.
INVESTIGATION AND DEVELOPMENT OF MODIFICATIONS TO RESOLVE AIRBORNE/GROUND GLIDEPATH TRACKING PROBLEMS Interim Report
Dave M. Staehling Oct. 1967 70 p
(Contract FA-67-WA-1636)
(RD-67-69; AD-665039)

Investigations were made to ascertain the cause or causes of tracking errors (discrepancies in course information derived from two separate glide path antennas) observed by FAA flight-check aircraft. A null reference/capture effect facility was installed at Mosby, Missouri and numerous tests were made. Most tests were made with a portable crankup tower to probe the path but flight checks were made, also. It was concluded that tracking errors are observed because: (1) There are vertically polarized components of signal in space that contain false course information. (2) The two aircraft receiving antennas do not reject these vertical signals sufficiently and differ in their degree of rejection of these vertical signals. Author (TAB)

N68-20033# Deutsche Gesellschaft fuer Ortung und Navigation e.v., Duesseldorf (West Germany).
NAVIGATION BY MEANS OF ARTIFICIAL SATELLITES [NAVIGATION MITTELS KUENSTLICHER SATELLITEN]
Feb. 1968 146 p refs In GERMAN

The passive and active methods of ship and aircraft positioning by satellite are described. Transit satellites, the Doppler navigation satellite systems, and several variations of these systems for determining distance and direction are discussed. A number of combined systems and proposals are also covered, among them automatic onboard navigation, a rate-range scheme for air and nautical navigation, use of the Omega and Synchronous Satellite

networks, and potential use of satellites in hyperbolic position finding. Evaluations and suggestions for satellite navigation systems by representatives of the maritime service and the airlines are included. Transl. by K.W.

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N68-19506# Argonne National Lab., Ill.
ANALOG ANALYSIS OF FLOW REVERSAL AND WATER-HAMMER PRESSURE IN A TYPICAL CLOSED AARR HYDRAULIC RABBIT-TUBE FACILITY
Raymond R. Rohde and Alan L. Winiecki Aug. 1967 23 p ref
(Contract W-31-109-ENG-38)
(ANL-7336) CFSTI: HC $3.00/MF $0.65

The transient conditions imposed on the hydraulic rabbit and the associated piping systems were investigated to aid in the selection of design parameters for a closed system (i.e., independent of the reactor primary system) for irradiation experiment sample insertion and removal in the Argonne Advanced Research Reactor (AARR). The water-hammer pressures and the rate of change of coolant flow, during the flow-reversal process, were analyzed for a typical AARR rabbit-tube system using an analog-computer system. The system characteristics, development of the mathematical model, and results recorded from the analog model are presented and discussed. NSA

N68-19552# Argonne National Lab., Ill.
REACTOR DEVELOPMENT PROGRAM Progress Report, Oct. 1967
30 Nov. 1967 185 p
(Contract W-31-109-ENG-38)
(ANL-7391) CFSTI: HC $3.00/MF $0.65

Research in the following areas is reported: reactor fuel elements; crucibles; uranium and plutonium carbides; mechanical properties of fuel elements and coatings research; liquid metal cooled reactors; breeder reactors; critical assemblies; fast test reactors; impurity detection in sodium; testing of prototype magnetic flowmeters; Experimental Breeder Reactor II technology; determination of carbon content in sodium; uranium alloys; fissium; superheaters; fast neutrons; uranium isotopes; reactor fuels; uranium oxides; plutonium oxides; ruthenium; Argonne advanced research reactor research; reactor safety; reactor safety experiments; and reactor containment structures. S.C.W.

N68-19554# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.
HETEROGENEITY CALCULATIONS INCLUDING SPACE DEPENDENT RESONANCE SELF-SHIELDING
D. Wintzer Oct. 1967 24 p refs Presented at the IAEA Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, Ger., 30 Oct.–3 Nov. 1967
(KFK-633; SM-101/13; EUR-3677.E)

An approximation method is described which takes into account space dependent self shielding in a multiregion lattice cell. The method is based on a multigroup collision probability formalism of reaction rates and neutron emission densities in the cell regions. The method is applied in a FORTRAN program ZERA which calculates group and region dependent reaction rates, k_{eff} values for unreflected lattices, and heterogeneity corrected cross sections which can be used to calculate heterogeneity effects in different regions of a reactor. The ZERA results agree with the bunching effects on reactivity and show the importance of the leakage component of heterogeneity effects in the outer regions of a reactor. The heterogeneity corrections to the diffusion coefficients allow an estimate of this component. The agreement between predicted and experimental results in a core boundary region in SNEAK-3A-1 is not yet satisfactory. R.N.A.

N68-19585# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
ASYMPTOTIC METHODS FOR SYSTEMS OF DIFFERENTIAL EQUATIONS IN WHICH SOME VARIABLES HAVE VERY SHORT RESPONSE TIMES
D. B. MacMillan 17 May 1967 6 p Presented at the 1967 Nat'l Meeting of the Soc. for Ind. and Appl. Math., Washington, D. C., 12–15 Jun. 1967
(Contract W-31-109-ENG-52)
(KAPL-P-3341; CONF-670624-1) CFSTI: HC $3.00/MF $0.65

A solution for systems of differential equations, which are applicable to thermal reactor kinetics, is presented. The solution employs asymptotic methods in systems where some variables have very short response times. A numerical application is presented for a point-model thermal reactor having six groups of delayed neutron emitters. NSA

N68-19587# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
NEUTRON ABSORPTION RATE PREDICTIONS FOR MATERIALS WITH ANISOTROPIC EFFECTIVE MACROSCOPIC CROSS SECTIONS
T. J. Kurey and H. J. Kopp 1967 18 p refs Presented at the Ann. Meeting of the Am. Nucl. Soc., San Diego, Calif., 11–15 Jun. 1967
(Contract W-31-109-ENG-52)
(KAPL-P-3340; CONF-670602-19) CFSTI: HC $3.00/MF $0.65

The effect of anisotropy of the microscopic self-shielding factors on the time-dependent nuclear properties of core elements was studied using a one-group transport equation that includes angular-dependent effective macroscopic cross sections. Calculations were performed for an array of poison elements situated in a fuel region, assuming isotropic macroscopic absorption and scattering cross sections for the fuel regions and an anisotropic effective macroscopic cross section for the absorber region. NSA

N68-19595# General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation.
FABRICATION AND MEASUREMENT OF PROPERTIES OF Mo–UO_2 CERMETS
J. F. Collins and P. N. Flagella 7 Jul. 1967 24 p refs
(Contract AT(40-1)-2847)
(GEMP-545) CFSTI: HC $3.00/MF $0.65

The fabrication of 90 specimens of various Mo–UO_2 fuel types and the measurement of tensile strength, thermal expansion, thermal conductivity, and sonic velocity is presented. Variables such as fuel particle size, fuel loading, and the effect of cladding or coatings of Mo over the Mo–UO_2 cermet were investigated. Author (NSA)

N68-19640# Brookhaven National Lab., Upton, N. Y.
SOME AEROSOL PROPERTIES OF VAPORIZED FAST REACTOR FUELS
Frederick L. Horn 1967 3 p Presented at the ANS Meeting, Chicago, 5–9 Nov. 1967 Sponsored by AEC
(BNL-11612; CONF-671102-20) CFSTI: HC $3.00/MF $0.65

Fuel materials, PuO_2 and UO_2, were vaporized rapidly to simulate an accidental release of fuel during a power excursion. Individual studies were made of the nature and coagulation behavior

of PuO_2 vaporized at 2800°C and UO_2 vaporized at 3000°C into both Ar and N gases, and of combinations of vaporized PuO_2–UO_2 and vaporized Na—UO_2 mixtures. NSA

N68-19641# Battelle Memorial Inst., Columbus, Ohio.
MECHANICAL AND PHYSICAL PROPERTIES OF FUELS AND CLADDING MATERIALS WITH POTENTIAL FOR USE IN BROOKHAVEN'S PULSED FAST REACTOR, PART 1
M. S. Farkas, ed. 27 Jul. 1967 225 p refs
(Contract W-7405-ENG-92)
(BMI-X-455, Pt. 1) CFSTI: HC $3.00/MF $0.65

A literature survey was conducted to provide mechanical and physical property data for unirradiated and irradiated fuels and cladding materials. The fuels include uranium alloys, plutonium alloys, and cermets. The cladding materials are iron-base alloys, nickel-base alloys, and molybdenum. These are of interest for potential use in Brookhaven's Pulsed Fast Reactor. NSA

N68-19664# Oak Ridge National Lab., Tenn.
FABRICATION OF INSTRUMENTED FUEL ELEMENTS AND IN-PILE CAPSULES
E. A. Franco-Ferreira and L. C. Williams Dec. 1967 33 p refs
(Contract W-7405-ENG-26)
(ORNL-4190) CFSTI: HC $3.00/MF $0.65

Techniques used at ORNL for fabricating and installing instrumented fuel elements and in-pile capsules are described. These techniques are specialized adaptations of welding and brazing which introduce the fewest extraneous variables into tests for evaluating the design, the fuel, and cladding materials of reactor fuel assemblies. The bulk of capsule instrumentation is in the form of thermocouples for measuring the temperature of the cladding and of the center of the fuel. Cladding temperature thermocouples were joined to the inside surface of the cladding by special brazing techniques. Fuel central temperature is measured by refractory- or noble-metal thermocouples contained in refractory-metal wells which pass through holes in the center of the fuel pellets. The thermocouple wells must be reliably sealed to stainless steel or other alloy end caps to prevent fission gas release. Methods of making transition joints for these dissimilar combinations were developed. Unique designs were also developed for making welded tungsten versus rhenium thermocouple junctions which would be resistant to failure due to thermal cycling. Methods used for making instrumented in-pile capsules were adapted to the production of five instrumented fuel assemblies for the Experimental Gas-Cooled Reactor at Oak Ridge. These fuel assemblies were intended to be the only in-core instrumentation in the reactor, and all reactor operation would be dependent on their functioning properly. Special, high-melting-point, refractory-metal-base brazing alloys were used in building refractory-metal in-pile capsules. The adaptation of electron beam brazing to their manufacture is also described. NSA

N68-19668 Tennessee Univ., Knoxville.
APPROXIMATE SOLUTION TO THE TIME DEPENDENT MULTIGROUP NEUTRON DIFFUSION EQUATIONS USING A RESTRICTED VARIATIONAL PRINCIPLE
James Conda Robinson (Ph.D. Thesis) 1966 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-7491

The purpose of this study was to develop an approximate solution for the time dependent multigroup neutron diffusion equations with temperature dependent parameters, thereby retaining a mechanism to permit a shift in the spatial or energy neutron spectrum during a transient. An approximate solution is obtained for the set of linearized neutron diffusion equations by assuming the neutron flux can be represented by linear combination of known spatial modes with time varying coefficients. The equations which determine the time varying coefficients are generated by applying a restricted variational principle. With the assumed solution for the forward and adjoint flux, the restricted variational principle leads to a coupled set of linear differential equations which determine the time varying coefficients appearing in the assumed solutions. Dissert. Abstr.

N68-19682# Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physikinstitut.
LATTICE VIBRATION IN Pt-CRYSTALS WITH DEFECTIVE Cu ATOMS [GITTERSCHWINGUNGEN IN Pt-KRISTALLEN MIT Cu DEFEKTATOMEN]
H. Fiedler (Wien Univ.) and O. J. Eder 1967 5 p refs In GERMAN; ENGLISH summary Presented at the Ann. Austrian Physicists Soc. Conv., Innsbruck, 1967
(Contract AF 61(052)-638)
(SGAE-PH-60/1967)

Inelastic neutron scattering experiments were carried out on pure Pt and on Pt–Cu alloy (5 atom% Cu) at two different sample temperatures (300°K, 930°K), using a rotating crystal spectrometer. The localized defect modes appearing in the neighborhood of the Cu-atoms were found at 28 MeV. Balcar has developed a method for calculation of defect modes which is based on macroscopic elastic properties of the pure crystal and does not require any knowledge of the frequency spectrum. A comparison between this theory and the experiment is carried out. Author

N68-19830*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 19: NUCLEAR ROCKETS
A. F. Lietzke Washington 1968 16 p Presented at Lewis Aerospace Explorers Conf., Cleveland, 1966–1967
(NASA-TM-X-52406) CFSTI: HC $3.00/MF $0.65 CSCL 21F

The functions, limitations, and expected performance of a nuclear rocket are described, and the difference between nuclear and chemical rockets is illustrated. Based on the interactions between neutrons and atomic nuclei, the operating principles of the nuclear rocket are delineated. The fission processes of uranium and plutonium are presented, and it is shown that by controlling the neutron population, the desired power may be obtained. An assessment is made of two thermal reactors and one a fast reactor, and the various functions and components of each are summarized. Diagrams are drawn to illustrate concepts discussed. B.S.D.

N68-19925*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
REACTIVITY EFFECTS CAUSED BY RADIAL POWER FLATTENING IN A SMALL, FAST-SPECTRUM REACTOR
C. L. Whitmarsh, Jr. Washington Apr. 1968 13 p refs
(NASA-TN-D-4458) CFSTI: HC $3.00/MF $0.65 CSCL 18I

The effect on criticality of flattening the radial power distribution in a small, reflector-controlled, fully enriched, fast-spectrum nuclear reactor was calculated. Compared to a uniformly fueled, fully enriched core, a decrease in reactivity occurred from reduced fuel inventory and an increase in reactivity occurred from enhanced reflector worth. Fuel distributions were also calculated to indicate the effects of (1) changing the power ratio of 1.1, and (2) changing the reflector thickness to 7.62 cm. Change (1) resulted in a zoned core with an enrichment variation from 71.3 percent in the central zone to 93.2 percent in the peripheral zone; whereas, for change (2) these values were 67 and 93.2 percent, respectively. The net reactivity loss (fuel loss–reflector worth increase) based on a 93.2 percent enriched uniformly-fueled core was 3 percent for either of these zoned cores. Power distortion in a reactor core is caused by reflector movement required to compensate for reactivity changes over the core lifetime. This effect in zoned cores was observed by calculating power shapes for the initial and the end-of-life reflector configurations for two zoned cores. Author

N68-19993# Argonne National Lab., Ill.
CONTROL AND STABILITY ANALYSIS OF SPATIALLY DEPENDENT NUCLEAR REACTOR SYSTEMS
Chun Hsu Jul. 1967 81 p refs
(Contract W-31-109-ENG-38)
(ANL-7322) CFSTI: HC$3.00/MF$0.65

A fundamental approach to the study of the dynamics of spatially dependent nuclear reactor systems is developed. This approach treats reactor dynamics problems from the system's partial-differential equations without finding the solution or engaging any approximation to a lumped-parameter model. A dynamical model of a spatially dependent process in nuclear reactors is formulated. The model is general and may include the spatial effects of deterministic processes such as control devices and temperature. The extended method of Liapunov, for distributed parameter systems, is then employed to analyze the stability of the system formulated above. A method of using the well-known spectral theory of Von Neumann is also introduced to analyze certain classes of linear and/or nonlinear spatially dependent dynamical systems. The application of the maximum principle to the optimal control system design for spatially dependent reactor systems is demonstrated for several classes of optimization problems. The practicality of optimal control for nonlinear systems is discussed, and a practical technique for suboptimal control design for nonlinear reactor systems using Liapunov functionals is introduced. 47 references.
Author (NSA)

N68-20195# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
DEVELOPMENT OF ^{60}CO CAPSULES FOR HEAT SOURCES
Charles P. Ross, Carl L. Angerman, and Franklin D. R. King Jun. 1967 49 p refs
(Contract AT(07-2)-1)
(DP-1096) CFSTI: HC$3.00/MF$0.65

Radioactive Co containing 100 curies of ^{60}Co per g of metal has been encapsulated in Inconel 600 and Hastelloy C containers. Such capsules, producing up to 250 w, have been tested successfully at 850°C for 100 hr in air. Longer tests are under way. Preliminary tests indicate that TD Nickel (2% ThO_2-dispersed) and TD Ni–Cr (78 Ni–20 Cr) are also promising materials for encapsulation. About 8 megacuries of ^{60}Co at activities up to 400 Ci/g will be available for heat source development and demonstrations by May 1967. Progress is reported in the areas of ^{60}Co production, fuel form properties, capsule design, capsule material properties, and capsule fabrication and testing.
Author (NSA)

N68-20365*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ACTIVATION OF SODIUM, LITHIUM, AND POTASSIUM IN COMPACT FAST REACTORS AND ITS EFFECT ON SHIELDING
Leonard Soffer Washington Apr. 1968 23 p refs
(NASA-TM-X-1512) CFSTI: HC$3.00/MF$0.65 CSCL 18J

Neutron activation of sodium (Na), lithium (Li), and potassium (K) used as possible coolants in a "typical" compact fast reactor were analytically investigated. The natural elements, all individual isotopes, and one common eutectic (NaK 78) were examined. Suitable energy dependent neutron fluxes were used in conjunction with activation cross sections to calculate saturated specific activities. Activation cross-section data for the elements studied were compiled and tabulated, and these data are judged to be adequate for engineering calculations. Results show that when zero holdup time is assumed, the best coolants, on the basis of unshielded activation dose rate, are K^{40}, K^{39}, Li^7, and natural Li. The worst are K^{41} and Na. Because of low natural abundance, K^{40} is impractical as a reactor coolant. Lithium dose rates are very sensitive to holdup time beause of the short (0.8 sec) half-lives of the Li products. Holdup of even a few seconds greatly reduces the Li dose rates but not those for any other element. Lithium 7 held up for 8 seconds and gave the lowest activation dose rate of any coolant considered. The unshielded dose rate from the assumed fission product release was the highest of all. It was about two orders of magnitude greater than the zero-holdup Li^7 rate, and about five orders of magnitude greater than the dose rate for Li^7 held up for 8 seconds. Gas evolution resulting from coolant irradiation was also investigated and found to be negligible except for Li^6.
Author

N68-20429# Oak Ridge National Lab., Tenn.
GENERAL FUELS AND MATERIALS RESEARCH, PART 3
In its Metals and Ceram. Div. Ann. Progr. Rept. for Period Ending Jun. 30, 1967 Nov. 1967 p 105–147 refs (See N68-20426 10-17)

Borating thorium powders containing 4.65% Zr in solid solution gave a product twice as hard at 800°C as competitive alloys in dispersion studies of solids. Good dispersion structures and high temperature strength were achieved in modified Ni-chrome and Vitallium type alloys containing thorium, and internally oxidized to give an ultrafine dispersion of very stable oxide particles. The successful operation of a flame reactor technique for direct conversion of UF_6 to uranium oxide powder is demonstrated. Other investigations in chemical vapor deposition include deposition of UO_2 from uranium chlorides and lithium reduction of UF_6 to produce uranium nitrides or carbides. Radiation damage to the mechanical properties of reactor materials and the development of modified alloys more resistant to radiation damage is examined. A computerized relaxation method and a closed-form solution for calculating parameters for induced electromagnetic fields are described. The potential of sol-gel-derived PuO_2–UO_2 fuel for fast reactors is assessed. The development of sintered aluminum products is examined, and the weldability of nickel and iron based alloys is studied. Stress and strain properties of zirconium alloys are described in terms of crystalline structure.
E.J.S.

N68-20430# Oak Ridge National Lab., Tenn.
REACTOR DEVELOPMENT SUPPORT, PART 4
In its Metals and Ceram. Div. Ann. Progr. Rept. for Period Ending Jun. 30, 1967 Nov. 1967 p 151–226 refs (See N68-20426 10-17)

Fuel rod spacer brazing, fuel rod end-cap welding, and pressure shell assembly brazing in support of BONUS reactor fuel element development are reported. New methods are described for screening structural alloys for weldability. The costs of fabricating and using an unclad uranium metal fuel element in a desalination reactor plant are analyzed. The postirradiation mechanical properties of Hastelloy N are examined in the temperature range from 600° to 800°C. Techniques are advanced for the fluidized-bed coating of particles, and the testing of coating materials and coated particle fuels. The design, fabrication, and validation of suitable targets for a high flux isotope reactor are described. The effects of operating environments are examined for graphite and Hastelloy N structural materials in the molten salt reactor. Four alternate fuel element designs are assessed from the standpoint of fuel fabrication costs and predicted performance in the heavy water, organic cooled reactor evaluation program. The thorium–uranium recycle facility is described.
E.J.S.

N68-20431# Oak Ridge National Lab., Tenn.
OTHER PROGRAM ACTIVITIES, PART 5
In its Metals and Ceram. Div. Ann. Progr. Rept. for Period Ending Jun. 30, 1967 Nov. 1967 p 229–247 refs (See N68-20426 10-17)

Procedures are described for gas tungsten arc welding of heavy walled, refractory alloy capsules in order to produce full-penetration welds for containers of alpha emitting isotopes. Electron beam welding techniques for sealing off the Hastelloy C capsule for SNAP 21 are also reported. Fluorescent penetrant and

ultrasonic inspection methods are evaluated for the inspection of capsule components, material, and welds in fueled capsules. Recommendations are made for the stress bearing encapsulating material in a Brayton cycle system with radioisotope heat source, as well as for materials with a diffusion barrier, oxidation protection, and a high emissivity coating. The use of an image analyzing computer for obtaining quantitative metallographic data is discussed. The data can be obtained directly from the specimen through a microscope, or with an attachment that accommodates all types of prints and negatives. Thermal cycling tests using Hastelloy X tube bundles to simulate Rover rocket nozzle materials are reported. E.J.S.

N68-20435# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
SPECTRUM INDEX LU:DY MICRODISTRIBUTION MEASUREMENTS IN "ANNA" REACTOR LATTICES
E. T. Jozefowicz, L. Adamski, and K. Jozefowicz 1967 12 p refs
(Rept.-821/9A/PR) CFSTI: $3.00

The detailed results of spectrum index Lu:Dy microdistribution measurements in the elementary cells of ANNA reactor lattices are given and are compared with theoretical calculations using K-7 THERMOS Code. Author

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N68-19503# Miami Univ., Coral Gables, Fla. Center for Theoretical Studies.
UNIVERSAL CONVENTIONALISM AND SPACE-TIME
Roman U. Sexl Aug. 1967 48 p refs Prepared in cooperation with Vienna Univ.
(CTS-PHIL-S-67-1; PB-176358) CFSTI: HC $3.00/MF $0.65

Geo-chronometric conventionalism is shown to be part of a more general thesis, universal conventionalism, stating that coordinative definitions are needed in order to compare two measurements of any physical quantity at different space-time points. Two fully elaborated examples of the use of non-standard coordinative definitions in physics are given, demonstrating that the use of these definitions can actually simplify the physical formalism. Finally, it is found that not only the metric of space-time is conventional (even non-Riemannian metrics are admissible), but also its topology and number of dimensions. Author

N68-19549# Ball Bros. Research Corp., Boulder, Colo.
MAGNETICS FOR OSO DESIGNERS
R. P. Woolley 15 Mar. 1967 67 p
(TN-67-10)

Consideration is given to the major constraints governing magnetic design and balancing of OSO experiment instruments. The ways in which magnetic materials cause trouble are delineated, allowable limits for magnetic materials are defined, and methods of estimating whether or not the planned equipment will be within the allowable limits are given. Simple measurements to determine if the existing equipment is within limits are described, and ways to bring it within these limits are suggested. The following are among the points made: (1) Use no material without knowing its magnetic properties. (2) If a component must be shielded from external fields, use no more shield than is needed and avoid long, narrow shapes. (3) If the magnet rotates in a way that changes the direction of its moment, its compensating magnet must rotate with it. (4) Use a compensating magnet instead of a shield to reduce the moment of a permanent magnet. M.G.J.

N68-19578*# National Bureau of Standards, Boulder, Colo.
CONTRIBUTION OF THERMAL NOISE TO THE LINE WIDTH OF JOSEPHSON RADIATION FROM SUPERCONDUCTING POINT CONTACTS
R. A. Kamper, A. H. Silver, and J. E. Zimmerman 14 Jul. 1967 3 p refs Supported in part by NASA Prepared in cooperation with Ford Motor Co., Dearborn, Mich.
(NASA-CR-93734; NBS-R-441; PB-176588) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The line-width of the Josephson oscillations of a voltage-biased superconducting point contact has been measured between 1.4 degrees K and 8 degrees K, with bias resistors R between 1.7×10 to the -10th power ohm and 2.6×10 to the -5 power ohm. Within the experimental accuracy the line-width is proportional to RT, and is consistent with the estimated theoretical value 8kTR/phi sub 0 squared, where k is Boltzmann's constant and phi sub 0 is the flux quantum. Line-widths below 0.1 Hz have been observed at 4.2 degrees K for R = 1.7×10 to the -10th power ohm, providing an experimental upper limit to the other noise sources and indicating that this is useful as a voltmeter and thermometer below 10 to the 16th power V and 10 to the -4 power K. Author

N68-19689 IIT Research Inst., Chicago, Ill.
DETERMINATION OF THE AVERAGE IMPULSE RESPONSE FOR A FLUIDIZED BED
Thomas John Fitzgerald (Ph.D. Thesis) 1966 119 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-7024

Experiments were conducted to compare the relative efficiencies of crosscorrelation and step response methods in obtaining the mean response to an impulse of tracer injected into the inlet gas stream of a fluidized bed. Tracer was monitored with a small probe just above the fluidized particles. Approximately ten thousand data points, corresponding to intervals of about one-thirtieth of a second, were used to determine the mean impulse response for each run. The tracer input for the crosscorrelation runs was a random on–off signal with switching intervals of one-tenth of a second, and was generated by sampling noise from a zener diode. The monitoring system used a small mass spectrometer modified for atmospheric sampling. The crosscorrelation method proved to be far more efficient, and its apparent speed of convergence compared well with theoretical estimates. The method is basically simple and should have utility in the measurement of average residence time distributions for noisy flow systems. Dissert. Abstr.

N68-19691 Syracuse Univ., N. Y.
A SESSILE DRIP STUDY OF LIQUID–SOLID ADHESION IN THE INDIUM–ALUMINUM SYSTEM USING ULTRA HIGH VACUUM TECHNIQUES
Robert George Aldrich (Ph.D. Thesis) 1966 97 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-7124

The fundamental equations governing the mechanical equilibrium of a liquid resting on a rigid, chemically inert, solid substrate were developed from the principles of reversible thermodynamics, and the expressions so obtained were used to determine the surface tension of liquid indium resting on a polycrystalline aluminum substrate by means of the sessile drop technique. To accomplish such an analysis a system was designed and developed capable of sustaining pressures of the order of 10^{-10} Torr (mm Hg), and withstanding bakeout temperatures to 450°C for a period of 15–24 hours. Dissert. Abstr.

N68-19784# Massachusetts Inst. of Tech., Cambridge.
THE OPTICAL PROPERTIES OF METAL BLACKS AND CARBON BLACKS
Louis Harris Dec. 1967 126 p refs *Its* Monograph Ser. No. 1
Prepared in cooperation with the Eppley Foundation for Research

The preparation of goldblacks, as well as other metal blacks and of different carbon blacks, is considered in detail. Recent transmittance and reflectance measurements have been combined with earlier ones to give tables of transmittance and reflectance for wavelengths from 0.254 to 40 microns for goldblacks, and to 18 microns for carbon blacks. The calculated absorptances, at different wavelengths, have been compared with the observed absorptances. The observed absorptances were found from the responses of radiation thermocouples, the receivers of which were coated with the different blacks. The calculated and observed absorptances were in good agreement for goldblacks and for Parsons optical black lacquer, and in partial agreement for lampblack paint. The relative merits of metal and carbon blacks, for radiation receivers, have been evaluated. The sintering observed for goldblacks heated above 100°C was found to be decreased by alloying the gold with copper or nickel. Author

N68-19816# Los Alamos Scientific Lab., N. Mex.
THE 1965 ARPA–AEC JOINT LIGHTNING STUDY AT LOS ALAMOS, VOLUME 2
Guy E. Barasch 9 Feb. 1968 18 p refs
(Contract W-7405-ENG-36; ARPA Order 631)
(LA-3755; AD-665141)

Collimated 50 degree-field photometers were operated during the 1965 lightning study to obtain data for an analysis of the production of false alarms in air-fluorescence nuclear-explosion detection systems. Detectors were employed in spectral regions useful for air-fluorescence detection. Observations were made on all types of lightning phenomena: leaders, return strokes, and inter- and intra-cloud processes. Author (TAB)

N68-19848 Oklahoma State Univ., Stillwater.
TIME DOMAIN REFLECTOMETRY FOR MEASURING VISCOELASTIC PROPERTIES
O'Neill James Burchett (Ph.D. Thesis) 1966 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-7198

The purpose of this research was to study methods of making ultrasonic measurements of physical properties in high-loss viscoelastic materials. The currently existing methods are limited in frequency power, and resolution. The solution consisted of first determining the factors which had made the norm material (urethanes) impossible to test ultrasonically for its physical properties. The solution consisted of devising an electronic reflectometer employing a unique gated oscillator system making possible the detection of shear waves at frequencies up to 2.25 megacycles. A unique method of identifying a desired ultrasonic wave was developed which aided the testing of the material. Ultrasonic wave measurements can be made on materials exhibiting a high degree of amplitude attenuation for ultrasonic waves. The increase in the attenuation with increase of frequency and temperature requires that an extremely high intensity pulsed sine wave be generated. Dissert. Abstr.

N68-19853 Syracuse Univ., N. Y.
SOME CAPABILITIES AND LIMITATIONS IN WAVEFRONT RECONSTRUCTION
Fred Irwin Diamond (Ph.D. Thesis) 1966 104 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-7068

In order to provide a firmer theoretical foundation, this dissertation presents the principles and limitations of wavefront reconstruction. Expressions are derived for the images produced by wavefront reconstruction; conditions for producing images are determined; and the effects of film size and film resolution are established. How these factors affect the limit of resolution are also delineated. Finally, some characteristics of the photographic recordings made with diffused coherent light are determined and described analytically. Their relations to three-dimensional wavefront-reconstruction are shown. Dissert. Abstr.

N68-19892# California Univ., Berkeley. Coll. of Engineering.
ELECTROMAGNETIC WAVE-CHARGE INTERACTION IN CROSSED FIELDS Quarterly Progress Report, 16 May–15 Aug. 1967
K. A. Fox, M. A. Meyer, S. Swierkowski, C. W. Turner, T. van Duzer et al Dec. 1967 37 p refs
(Contract DAAB07-67-C-0227)
(QPR-1; ECOM-0227-1; AD-664802)

The purpose of the work on this contract is to investigate the interaction of electromagnetic waves and electrons in vacuum and solids. The design of a crossed-field amplifier which will incorporate the results of our noise studies has been initiated. The paraxial crossed-field gun design method developed by Rao is being carried on to obtain designs for magnetically shielded guns. A study of the practicality of deriving pulsed emission in crossed-field guns by optical stimulation using a laser beam is being conducted. Experimental studies of crossed-field, acoustic-wave amplification have been conducted and theoretical work has been done to tie this effect in with acousto-electric oscillations. Experiments have been performed to look for the solid-state-plasma waves which our theoretical work has predicted. TAB

N68-19920 Minnesota Univ., Minneapolis.
TRANSPORT PHENOMENA IN LIQUID CRYSTALS
Joseph Thomas Sullivan (Ph.D. Thesis) 1966 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-7792

A theoretical description of the continuum behavior of transport processes in nematic liquid crystalline materials is based on inferences from past experimental research on liquid crystals and other fluids which display ordered molecular orientation. The theory can be applied under both static and dynamic conditions. It is used to deduce the results of possible experimental situations. An equation of change is first developed to describe the angular distribution of molecular orientation at a point within the fluid as a function of time and position. Molecules are assumed to be transversely isotropic. Ordered orientation (anisotropy) in this distribution is assumed to be the result of proximity to surfaces, of external fields, particularly shear fields, and of relaxation due to rotational diffusion. A tensor, called the *anisotropy tensor*, is then defined in terms of moments of the distribution function of molecular orientation. Dissert. Abstr.

N68-19952# Arizona Univ., Tucson. Optical Sciences.
INTERACTION OF AN OPTICAL SYSTEM WITH THE INCOMING WAVEFRONT IN THE PRESENCE OF ATMOSPHERIC TURBULENCE
R. V. Shack 28 Aug. 1967 49 p refs
(TR-19; PB-176886) CFSTI: HC $3.00/MF $0.65

The classical properties of an image formed by an optical system looking through a turbulent medium are scintillation, agitation, and blur. A simple but adequate statistical model is obtained describing the pupil function in the presence of random wavefront disturbances in both amplitude and phase. A measure of scintillation is then obtained in the form of a normalized, weighted integral in frequency space containing all the pertinent properties of the optical system. A similar measure of agitation is then developed, and finally a description of the blur is obtained in the form of an equivalent transfer function for the turbulent medium in which the contribution from amplitude variations and the contribution from phase variations are independent. Author

N68-19996# Utah Univ., Salt Lake City. Electrical Engineering Dept.
STUDY OF TRANSVERSE WAVE INTERACTIONS Triannual Report, May 1–Aug. 31, 1967
K. I. Talbot, C. H. Durney, and R. W. Grow Dec. 1967 19 p refs
(Contract DA-28-043-AMC-01279(E))
(UTEC-MD-67-052; ECOM-01279-8; Rept.-8; AD-664779)

The purpose of the project is to evaluate analytically and experimentally the interaction of waves in a wave guide with waves on a rotating electron beam. The methods of analysis include use of a general coupled-mode theory, a ballistic computer program, and an experimental evaluation. Theoretical work has centered on the transverse bunching effect. It was found that when the absolute value of the bunching parameter zeta, which is related to the magnitudes of the beam modes, is greater than one, electrons pass each other. From criteria based on consideration of the ordinary backward-wave oscillator, it appears that power saturation occurs when electrons begin to pass each other. The construction of the new tube is finished and it is being tested. Initial power measurements indicate that the power output is lower than that obtained from the previous tube. It is expected that the power output will be increased. Author (TAB)

N68-20003# Michigan State Univ., East Lansing. Ultrasonics Lab.
MEASUREMENT OF THE VELOCITY OF SOUND IN WATER BY OPTICAL METHODS
Arthur Jared Crandall 15 Nov. 1967 64 p refs
(Contract Nonr-2587(00); Grant NSF-GP-4210)
(TR-17; AD-664664)

Several new optical methods have been developed for the measurement of sound velocities in transparent fluids. The visibility pattern from stationary, progressive and pulsed progressive waves are detected by a fast response photomultiplier tube rather than visually, which allows the use of lower sound intensities. A theoretical expression is developed for the errors caused by diffraction in the near field of a circular transducer. The velocity of sound in distilled water was measured to be 1517.70 plus or minus .20 m/sec at a temperature of 34.00C. Author (TAB)

N68-20032 Maryland Univ., College Park.
RELATIVISTIC DESCRIPTIONS OF MATERIAL SOURCES FOR GRAVITATIONAL FIELDS INCLUDING ELASTIC MATERIALS AS SOURCES OF ASYMMETRIC STATIC FIELDS
Walter Charles Hernandez, Jr. (Ph.D. Thesis) 1966 91 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-6141

Several methods which might be useful for obtaining interior solutions which describe material sources in general relativity have been investigated. The relativistic equations describing spherical gravitational collapse with non-zero pressure are reformulated using observer (retarded) time as the t coordinate. Two methods for obtaining non-spherically symmetric static interior solutions in general relativity are discussed. The prime motive for this is that we hope to learn something about handling non-spherically symmetric problems for later extension to rotating systems. In the first method we guess a field $g_{\mu\nu}$ which might serve as the source of one of the Weyl axially symmetric exterior solutions and verify that it is not physically unreasonable. In the second method we are given the equation of state, etc., of the material and would like to devise a scheme for obtaining solutions of the static general relativistic equations. A relativistic elastic theory which is needed for this second method is developed since any static fluid would presumably yield a spherically symmetric solution. An absolute strain is also defined which is consistent with classical elastic theory.
Dissert. Abstr.

N68-20053*# College of the Holy Cross, Worcester, Mass.
REPLICA GRATING STUDY Interim Report, 1 Jul.–31 Dec. 1967
Roy C. Gunter, Jr. 15 Feb. 1968 18 p ref
(Grant NGR-22-091-002)
(NASA-CR-93782) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Thermal-vacuum stressing of concave replica diffraction gratings from three different manufacturers for several days at pressures encountered by orbiting satellites indicates that they will withstand at least temperatures from +20°C to −5°C. An irradiated plane replica diffraction grating withstood at least 140°C temperatures for 24 hours at atmospheric pressure with no significant deterioration. Plane replica diffraction gratings that had been previously irradiated withstood temperatures of at least 87°C for 24 hours before failure was detected. Continuation of the irradiation of plane replica diffraction gratings using BSC2 and synthetic fused silica seems to indicate clearly that at least with electrons of 1.2 Mev energy, the deformation is due to the substrate rather than to the replication process. For the most radiation sensitive material tested thus far, Pyrex, deformations of one-quarter wavelength were not reached until the dose exceeded 6×10^{12} electrons/cm^2.
Author

N68-20055 Iowa State Univ. of Science and Technology, Ames.
ELECTRICAL RESISTIVITY OF CARBON GRANULES IN A FLUIDIZED BED
Arthur Lowell Jones (Ph.D. Thesis) 1966 188 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-5600

The purpose of this investigation was to study the parameters affecting the apparent resistivity of a fluidized bed of carbon granules, to determine which parameters were important, and to correlate these parameters by means of a mathematical expression which could be used to predict the apparent resistivity. All determinations were made at room temperature. The method used in determining resistivity values was the four terminal method of resistance measurement which employed two current terminals and two potential terminals. The use of this method eliminated any contact resistance between the potential terminals and the bed. Measurements of current and voltage drop together with bed dimensions gave values for the apparent resistivity according to the relationship $R = \rho L/A$, where R is resistance, ρ is apparent resistivity, L is the distance between probes and A is the cross-sectional area of the fluidized bed. Dissert. Abstr.

N68-20094*# Massachusetts Inst. of Tech., Cambridge.
JET NOISE AND SHEAR FLOW INSTABILITY SEEN FROM AN EXPERIMENTER'S VIEWPOINT
Erik Mollo-Christensen [1967] 44 p refs
(Grants NsG-31-60; NsG-496)
(NASA-CR-93838) CFSTI: HC $3.00/MF $0.65 CSCL 20A

A discussion is presented of similarity laws for jet noise as suggested by experiments. A model line emitter is constructed, and near field pressure covariance and spectra are presented. Phase coherence of the near pressure field and nonlinear coupling in the generation of turbulence are demonstrated. Author

N68-20124# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
DYNAMIC STABILITY OF A PENDULUM UNDER COEXISTENCE OF PARAMETRIC AND FORCED EXCITATION
Chandramohan K. Chhatpar and John Dugundji Dec. 1967 109 p refs
(Contract AF 49(638)-1528)
(ASRL-TR-134-5; AFOSR-68-0001; AD-665118)

As background for the dynamic stability of structures, a pendulum undergoing combined parametric and forced excitation is examined. The behavior near the second instability region of the Mathieu equation, omega approximately equal to omega sub N, is

studied in detail. Theoretically, steady-state and complete transient solutions are developed here for linear and nonlinear theory. Experimentally, the pendulum was excited and both transient and steady-state records were obtained. The overall response indicated two main resonance regions: one where forced excitation was predominant near omega approximately equal to omega sub N, and another for parametric excitation near omega approximately equal to 2 omega sub N. Some other peculiar steady-state responses were also noted. TAB

N68-20218 Illinois Univ., Urbana.
MAGNETIC PROPERTIES OF DILUTE SOLUTIONS OF LIQUID HE^3 IN HE^4 AT LOW TEMPERATURES
Raymond Joseph Sarwinski (Ph.D. Thesis) 1966 125 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-6722

The spin-diffusion coefficient and magnetic susceptibility of dilute solutions of He^3 in He^4 has been measured down to about 3m°K. These measurements were made on two solutions of nominal concentrations of 1.3 and 5.0% He^3 in He^4 under their own vapor pressures. The values of the diffusion coefficient fit T^{*-2} laws below about 10m°K for the 1.3% and below about 30m° K for the 5.0% solutions in agreement with the Landau model of a Fermi liquid. The susceptibility is found to be constant at sufficiently low temperatures also in agreement with the Landau model. Dilute solutions of He^3 in He^4 are found to behave as weakly interacting Fermi systems with the advantage that the concentration, and therefore the Fermi temperature, can be varied from 0 to about 6% He^3. Since the system is weakly interacting, perturbation theory can be applied and the effective interaction potential between He^3 particles can be deduced from measurements of the properties of these solutions at different concentrations. Dissert. Abstr.

N68-20242# Southampton Univ. (England). Inst. of Sound and Vibration Research.
ANNUAL REPORT FOR THE YEAR ENDING JUNE 1967
Jun. 1967 155 p refs
CFSTI: HC $3.00/MF $0.65

Research activities of the fundamental acoustics and aerodynamic group, the structures and vibrations group, the audiology, and the industrial acoustics and instrumentation group are reviewed. The report concludes with the educational program and the publications. ESRO

N68-20268# Massachusetts Univ., Amherst. Polymer Research Inst.
DYNAMIC X-RAY DIFFRACTION FROM POLYETHYLENE
Tatsuro Kawaguchi, Taisuke Itoh, Hiromichi Kawai, Daniel Keedy, and Richard S. Stein Nov. 1967 65 p refs Sponsored in part by Petrol. Res. Fund and Monsanto Corp.
(Contract Nonr-3357(01))
(ONR-TR-97; AD-664955)

The technique of dynamic x-ray diffraction is described in which the periodically varying diffracted x-ray intensity is analyzed for a sample of a polymer film subjected to a periodic strain. The intensity change may be resolved into a real part, delta I, varying in-phase with the strain and an imaginary out-of-phase component, delta I. This resolution is carried out for the amorphous scattering and the diffraction from two planes of medium density polyethylene at 30C and at frequencies between 0.02 and 1.25 HZ. Delta I decreases with frequency and delta I increases with frequency in the range as a consequence of a crystal orientation process having a relaxation time of the order of 1 sec. Measurements at temperatures of 30, 45, and 60C produce a frequency shift associated with an activation energy of 25 Kcal/mole which is close to that for the alpha-2 process studied mechanically. By integrating the delta I values over azimuthal angle it is possible to determine the real and imaginary parts of the dynamic orientation function, delta f and delta f. Author (TAB)

N68-20318# Institut Franco-Allemand de Recherches, St. Louis (France).
HOLOGRAPHY OF MOVING OBJECTS [HOLOGRAPHIE DES OBJETS EN MOUVEMENT]
P. Smigielski 1966 11 p refs In FRENCH
(ISL-T-13/66) CFSTI: HC $3.00/MF $0.65

The vibrational effects of structural components in a holographic system on picture quality were analyzed. Basic equations for the representation of slow moving objects were formed and applied to special problems in holography by separating the motion vector into tangential and radial components. The tanential effect blurs the reconstructed picture and the radial effect represents the focusing error and shows up as a band in the picture.
Transl. by G.G.

N68-20420# Illinois Univ., Urbana. Dept. of Civil Engineering.
A DISCRETE EULERIAN MODEL FOR SPHERICAL WAVE PROPAGATION IN COMPRESSIBLE MEDIA
E. Faccioli and A. H.-S. Ang Jan. 1968 128 p refs *Its* Struct. Res. Ser. No. 330
(Grant NSF GK-589)
(PB-177297) CFSTI: HC $3.00/MF $0.65

An Eulerian model based on cell-analogues of the integral conservation laws of continuous media is proposed, which leads to finite-difference equations explicitly conserving mass, momentum and energy. The model is primarily intended for describing ground motions in the relatively low pressure regions of the dynamic environment of underground nuclear bursts. A class of boundary value problems that can be handled with the model is represented by the expansion of a spherical cavity under a prescribed pressure pulse simulating the effects of the close-in region. Illustrative problems include the elastic–plastic wave propagation in granite, and shock formation and attenuation in playa silt. Author

N68-20421# International Centre for Theoretical Physics, Trieste (Italy).
A SYSTEMATIC SEARCH FOR NON-RELATIVISTIC SYSTEMS WITH DYNAMICAL SYMMETRIES. PART 1: THE INTEGRALS OF MOTION
A. A. Makarov (Joint Inst. for Nucl. Res.), J. A. Smorodinsky (Joint Inst. for Nucl. Res.), Kh. Valiev (Joint Inst. for Nucl. Res.), and P. Winternitz (Joint Inst. for Nucl. Res.) Feb. 1967 28 p refs Submitted for publication Sponsored by Intern. Atomic Energy Agency and UNESCO
(IC/67/8) CFSTI: HC $3.00/MF $0.65

This paper is part of a systematic investigation, the aim of which is to find, with certain restrictions, all potentials allowing a dynamical (or higher) invariance group, within the framework of non-relativistic quantum mechanics. All potentials were found for which a pair of linear operators exists, commuting with a non-relativistic Hamiltonian and with each other and the corresponding integrals of motion are listed. Also are listed all potentials allowing the separation of variables in spherical coordinates and in at least one additional coordinate system. ESRO

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N68-19505# Uppsala Univ. (Sweden). Inst. of Physics.
NUCLEAR LEVELS OF DY^{162}
A. Baecklin, A. Suarez, O. W. B. Schult, B. P. K. Maier, U. Gruber et al 1967 37 p refs
(TID-23909; LF-18; LA-DC-8526) CFSTI: HC $3.00/MF $0.65

The nuclear level scheme of ^{162}Dy was studied utilizing a variety of experimental methods. From the reaction ^{161}Dy(n,γ)^{162}Dy, low-energy gamma-ray transitions were measured between 40 and ≈1350 keV with a bent crystal spectrometer, and the (n,e$^-$) conversion-electron spectrum was investigated in the energy range between 160 and 1300 keV with a double-focusing beta spectrometer. Altogether, some 160 transitions were found, and multipolarities were assigned for about 50 of these. High-energy gamma rays from neutron capture in ^{161}Dy were measured in the energy region between 4.9 and 8.2 MeV with a Ge(Li) detector operated in the pair mode; 49 transitions were found. Furthermore, the reactions ^{162}Dy(p,p'), ^{162}Dy(d,d'), ^{161}Dy(d,p), and ^{163}Dy(d,t) were studied at 12-MeV beam energy, using a broad-range magnetic spectrograph. Combining the results of all these experiments, a level scheme containing 90% of the intensity of the low energy (n,γ) spectrum of ^{162}Dy was constructed consisting of the following levels: the ground-state rotational band up to the 8$^+$ level; the K = 2$^+$ (gamma vibrational) band at 888.22 keV including all members up to the possible 7$^+$ state; the K = 2$^-$ octupole vibrational or [411↓−523↓] band with the band head at 1148.29 keV and including members up to the tentative 5$^-$ and 6$^-$ levels; the K = 4$^-$[521↑ + 523↓] band at 1535.89 keV containing members up to the 6$^+$, and possibly the 7$^+$ level; a K = 0$^-$ band (probably octupole) with 1$^-$ and 3$^-$ members at 1275.4 keV and 1357.0 keV, and possibly the 5$^-$ member at 1520 keV; a tentative K = 0$^+$ band with 2$^+$ and 4$^+$ members at 1206.1 and 1390.3 keV, suggesting that 0$^+$ level at 1127 keV; the [521↑ − 523↓]K = 1$^+$ band at 1745 keV containing states up to the 6$^+$ level; the K = 3$^-$[642↑ + 521↓] band at 1770 keV containing levels up to the 6$^-$ member and finally the K=2$^-$ [642↑−521↓] band at 1866 keV containing levels up to the 5$^-$ state. Other unassigned levels were found above 1.4 MeV in the (d,p), (d,t), and high-energy (n,γ) measurements. The agreement between experimental and calculated cross sections for the (d,t) and (d,p) reactions was found to be good for the [521↑±523↓] and the [642↑ ±521↓] states, but not so good for the [642↑±523↓] states. The neutron binding energy in ^{162}Dy was determined to be 8192.8 ± 3 keV. Author (NSA)

N68-19513# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
PROBLEM OF CONSTRUCTION OF THE UNITARY RENORMALIZABLE FIELD THEORY WITHOUT ULTRAVIOLET DIVERGENCES
M. K. Volkov 1967 14 p refs
(JINR-E2-3266)

A four-dimensional unitary relativistic model of quantum field theory without ultraviolet divergences with a nonunit S-matrix was constructed on the basis of the Lagrangian $L_{int}(x) = \Delta m: \bar{\psi}(x)\,\tau_3\,e^{-12g\tau_3\phi(x)}\psi(x)$. Author (NSA)

N68-19529# Illinois Univ., Urbana. Dept. of Physics.
STRANGE PARTICLE PRODUCTION IN π^-P AND π^+N INTERACTIONS AT 2.5 GEV/C
Raymond William Hanft (Ph.D. Thesis) Jun. 1967 197 p refs
(Contract AT(11-1)-1195)
(COO-1195-94) CFSTI: HC$3.00/MF$0.65

A bubble chamber experiment based upon 2.71×10^5 m π^- track length in hydrogen and 6.88×10^5 m π^+ track length in deuterium was performed to study strange particle production. In extracting information about π^+n interactions from the π+D exposure it was found that 15 to 30% of events, depending on the final state particles, had protons with momentum greater than 250 MeV/c. These protons were not isotropic in the laboratory and therefore not spectators in the sense of the impulse approximation. With the inclusion of the high proton momentum events the cross sections for processes apparently arising from π^+n interactions were found to be in satisfactory agreement with cross sections for the charge symmetric π^-p reactions. In the reaction π^+n → $K^0(K^0)$p evidence for weak φ production corresponding to about 10 μb cross section was obtained. No other enhancements in the $K\bar{K}$ or $K\bar{K}\pi$ systems were seen. YKπ and YK$\pi\pi$ states were found to be dominated by resonance production. Author (NSA)

N68-19631# Texas Univ., Austin. Center for Nuclear Studies.
BRIGIT
C. Fred Moore and Leslie Parish 17 Aug. 1967 20 p refs
(Contract AT(40-1)-2972)
(ORO-2972-34; TR-2) CFSTI: HC$3.00/MF$0.65

The computer program BRIGIT which was written to fit proton elastic scattering resonances in order to extract resonance parameters is described. The theoretical formulation is outlined. NSA

N68-19536# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.
STIMULATED EMISSION IN POLYATOMIC MOLECULES
W. Charles Carr and Richard W. Grow Sep. 1967 217 p refs
(Grants NSF GP-843; NSF GK-29; NSF GK-1644)
(UTEC-MD-68-015)

The general theory for obtaining stimulated emission and various mechanisms by which the necessary population inversions may be achieved are presented. The excitation process as it relates to molecules rather than atoms is discussed and the specific requirements for dissociation and excitation of $SiCl_4$ and $SnCl_4$ molecules are given. Details of the laser system and the general procedures and techniques which led to the successful observation of stimulated emission in $SiCl_4$ and $SnCl_4$ are described. The original hypothesis that high vapor pressure polyatomic molecules might be used as the active medium in a gas laser in place of the corresponding normally solid element vaporized in a high temperature furnace was verified with the observation of stimulated emission in $SiCl_4$ $SnCl_4$ $SnBr_4$ and SnI_4 This method of obtaining stimulated emission makes it possible to investigate lasing action in these elements by using molecular compounds of high vapor pressure as well as in elements previously not investigated. R.N.A.

N68-19543# Lyon Univ. (France).
CONTRIBUTION TO THE STUDY OF EXCITED LEVELS OF ^{61}NI AND ^{200}HG BY MEANS OF A GE(LI) DETECTOR [CONTRIBUTION A L'ETUDE DES NIVEAUX EXCITES DU NI^{61} ET DU HG^{200} A L'AIDE D'UN DETECTEUR GE(LI)]
Robert Beraud (Ph.D. Thesis) Jun. 1967 58 p refs In FRENCH
(LYCEN-67-45)

The characteristics of a Ge(Li) detector were determined with respect to its utilization in spectrometer measurements and in the measurement of angular correlation. The detector was used to study the decay of ^{61}Cu → ^{61}Ni and ^{200}Tl → ^{200}Hg, making it possible to define the level scheme of the end nuclei. The operational principles of Ge(Li) detectors are first reviewed. The energies of fourteen new transitions in the energy levels of ^{61}Ni were determined with a precision of the order of 1 keV and the intensities of 20 de-excitation γ rays of ^{200}Hg were measured. The results are tabulated. NSA

N68-19547# Helsinki Univ. (Finland). Dept. of Technical Physics.
STUDIES OF THE PRINCIPLE OF SUPERPOSITION IN QUANTUM MECHANICS
Matts Roos (Ph.D. Thesis) 1966 15 p refs Repr. from Commentationes Physico-Math., v. 33, no. 1, 1966

The notions of state and completeness are reviewed. The principle of superposition (PSP) is formulated for the case of a finite number of basic states. The physical content of PSP in this case is discussed and illustrated by a Gedanken-experiment using a double Stern–Gerlach experiment. The possibility of explaining the K_L^0 meson $\pi^+\pi^-$ decay as a CP-invariant violation of PSP is reviewed in the light of experimental information. Author

N68-19557# Paris Univ., Orsay (France).
PION–PION S WAVE AND NUCLEON–NUCLEON INTERACTION [ONDE S PION–PION ET INTERACTION NUCLEON–NUCLEON]
P. Gauron May 1967 6 p refs In FRENCH
(IPNO/TH-88)

The nucleon–nucleon phase shift was calculated using a pion–pion S wave model. The parameters of this model were fixed by means of experimental results on pion–nucleon scattering. The results show that the two π basic term is weak and can be neglected. The introduction of the pion–pion S wave model made it possible to include the contribution of ω in the experimental results. NSA

N68-19569# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
A DAUGHTER REGGE TRAJECTORY IN THE BETHE–SALPETER EQUATION
M. Fontannaz Jan. 1968 29 p refs
(TH/233) CFSTI: HC$3.00/MF$0.65

We solve the Bethe–Salpeter equation in the ladder approximation of the $\lambda \Phi^3$ theory by the Fredholm method. An implicit equation for the Regge trajectories is obtained by putting the Fredholm determinant equal to zero. In the weak coupling limit we get the following results: (a) Equal-mass case: The first daughter trajectory is horizontal at the first order in the coupling constant and the residue of the pole vanishes at all orders of the coupling constant. (b) Unequal-mass case: At $s = 0$, the slope of the daughter is positive and smaller than that of the mother if the relative mass difference $(m^2-\mu^2)/\mu^2 = x$ is not too great. It becomes negative when x increases. The residue of the pole has the characteristic behavior in $(m^2-\mu^2)^2/s$ for s close to zero. We also find two other trajectories, the slope of one of them is negative for certain values of the masses. Author

N68-19586# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
SPIN-QUADRUPOLE FORCES AND COLLECTIVE STATES IN DEFORMED NUCLEI. 2: 2^+ STATES
M. I. Chernei and N. I. Pyatov 1967 18 p refs
(JINR-E4-3134)

Numerical calculations of the energy, E2 transition probability, and one-phonon wave function for the 2^+ collective states in rare-earth deformed nuclei are carried out within the framework of the model with spin-quadrupole interactions. It is shown that the spin-quadrupole interactions affect slightly the energy and E2 transition probability for the lowest 2^+ state. But the spin-quadrupole interactions lead to the significant lowering of the second 2^+ collective state below the two-quasiparticle energy. They affect the decay properties of this state as well. The effect of the spin-quadrupole interactions on the one phonon wave-function structure is also discussed. Author (NSA)

N68-19588# Oak Ridge National Lab., Tenn.
P,N AND D,N TIME-OF-FLIGHT EXPERIMENTS
P. H. Stelson [1967] 31 p refs Presented at Symp. on Nucl. Phys. Res. with Low Energy Accelerators, College Park, Md.
(Contract W-7405-ENG-26)
(ORNL-P-3206; CONF-670615-3) CFSTI: HC$3.00/MF$0.65

The resolution of neutron groups in time-of-flight experiments is discussed with emphasis on (d,n) and (p,n) reactions. Some (d,n) and (p,n) experiments are summarized. NSA

N68-19594 European Organization for Nuclear Research, Geneva (Switzerland).
PROCEEDINGS OF THE 1967 CERN SCHOOL OF PHYSICS, VOLUME 2
B. E. Y. Svensson 20 Dec. 1967 214 p refs Lectures held at Rattvik, Switzerland, 21 May–3 Jun. 1967
(CERN-67-24, V. 2)

The basic theoretical arguments underlying the Regge pole model and its applications to particle classification and high energy reactions are presented. Some fundamental theoretical concepts used in analyzing scattering experiments, particularly at high energies, are reviewed. These include the kinematics of two-body reactions, scattering amplitudes and cross sections, and partial wave analysis. A survey is made of experimental results on total cross sections, most aspects of elastic scattering, and some representative inelastic two-body processes. A brief description and history of the Regge pole model are given along with a discussion of Reggie poles in potential scattering. The basis for classification of hadrons on Regge trajectories is explained and illustrated by the non-strange mesons and fermions. The application of the Regge pole model to high energy reactions is illustrated in detail for pion–nucleon elastic and charge exchange scattering. Nucleon–nucleon and kaon–nucleon reactions are briefly treated. R.N.A.

N68-19596# Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires.
PROPAGATION OF THERMAL NEUTRONS IN MOCK-UP SCREW-SHAPED STEEL ELEMENTS WITH WATER PROTECTION [PROPAGATION DES NEUTRONS THERMIQUES DANS DES FAUSSES CARTOUCHES D'ACIER EN HELICE DANS UNE PROTECTION D'EAU. PROGRAMME TOURNESOL 3]
Christian Devilers and Jeanne-Marie Lanore Apr. 1967 68 p refs In FRENCH
(CEA-R-3196)

The streaming of thermal neutrons in a cylindrical duct in light water is treated. The duct contains an helicoidal iron shield. Transmission and reflection matrixes are used to describe the probabilities for the thermal neutrons to be absorbed or to be scattered on the surfaces. The neutron paths across the void are represented by geometrical matrixes. The numerical resolution is performed by the Monte Carlo method. Author (NSA)

N68-19625# Nihon Univ., Tokyo (Japan).
RELATIVISTIC RIGID SPHERE AS AN EXAMPLE OF THE UNIFIED MODEL OF ELEMENTARY PARTICLES
Osamu Hara, Tetsuo Goto, S. Y. Tsai, and Haruichi Yabuki [1967] 45 p refs
(NUP-A-68-1) CFSTI: HC$3.00/MF$0.65

A relativistic formulation of a rigid sphere is presented as the simplest example of the relativistic theory of the unified model of elementary particles based upon the non-point model. This model gives particles with integer and half-integer spin $J = 0, 1/2, 1, \ldots$, baryonic (leptonic number 0, $\pm 1, \ldots\ldots \pm 2J$ and mass $J(J+1)/2I$, where J and I denote the spin and the moment of inertia respectively. The quantum mechanical equation of motion to be satisfied by such a system is a generalization of the Feynman–Gell–Mann equation to arbitrary spin, which is equivalent to the generalized Dirac equation. It is also shown that in this model the mirror image of a particle is its antiparticle. Therefore, it leads to the conservation of CP, rather than the conservation of P. Author

N68-19637# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
TWO-POINT FUNCTIONS [DVUKHTOCHECHNYE FUNKTSII]
I. A. Eganova and M. I. Shirokov 1967 18 p refs In RUSSIAN
(JINR-P4-3354)

It is known that the scattering of a low-energy particle by the potential of small radius is satisfactorily described by the s-wave alone. A method is given for obtaining the functions with the aid of which one can describe by only two waves the scattering by two localized potentials separated by an arbitrary distance 2d. Two-point solenoidal vector functions are also obtained. In the two-center case, they play the same role as the known electric and

magnetic multipoles in the one-center problems (e.g., the problems of scattering or emission of a photon in the dipole approximation). Author (NSA)

N68-19638# Illinois Univ., Urbana. Dept. of Physics.
MEASUREMENT OF THE RELATIVE PARTIAL DECAY RATES FOR $K^+ \rightarrow \pi^\pm \pi^+ \pi^-$
Charles Roberts Fletcher (Ph.D. Thesis) 1967 103 p refs
(Contract AT(11-1)-1195)
(COO-1195-98) CFSTI: HC $3.00/MF $0.65

A spark chamber experiment was performed to measure the relative partial decay rates of positive and negative kaons decaying in the tau mode, $K^\pm \rightarrow \pi^\pm \pi^+ \pi^-$. The ratio measured was $[\Gamma(--+)/\Gamma(++-)]$. The corrected value for the relative tau decay rates was $[\Gamma(--+)/\Gamma(++-)] = 1.005 \pm .009$. This result is consistent with four interpretations: There is no CP violation in $K^\pm \rightarrow (3\pi)^\pm$ as seen in the relative tau rates within the experimental error of 0.9%. There are no final state pion interactions. There is a negligible $I=3$ contribution to the tau matrix element. There are weak final state pion interactions and a small $I=3$ amplitude. NSA

N68-19648# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
DIFFRACTION METHOD FOR STUDYING STRIPPING REACTION ON DEFORMED NUCLEI [DIFRAKTSIONNOE RASSMOTRENIE REAKTSII SRYVA NA DEFORMIROVANNYKH YADRAKH]
V. K. Luk'yanov and I. Zh. Petkov 1967 27 p refs In RUSSIAN
(JINR-P4-3447)

Stripping and pickup reactions were found to be useful for obtaining information on the properties of deformed nuclei, such as the spectra of the emitted particles and differential cross sections. For direct processes, the distorted-wave method was found to be very useful. In this connection, the contribution of all of the rotational levels of the nuclei to the cross section were considered, studying the stripping process on deformed nuclei, without using the perturbation theory as a parameter of the deformation. The study involved investigation of the distorted waves within the field of a deformed nucleus. The expression obtained contained, in addition to the usual terms related to one-stage stripping, those of multistage stripping reactions which are of interest for the excitation of reactions at higher rotational levels. The diffraction method allowed one to simplify the expression for the stripping cross section. The angular distributions in such reactions were quantitatively analyzed, using the $^{24}Mg(d,p)^{25}Md$ reaction as an illustration for the comparison of theoretical and experimental results. NSA

N68-19655# Oak Ridge National Lab., Tenn.
RADIATION PHYSICS, PART 3
G. S. Hurst *In its* Health Phys. Div. Oct. 1967 p 119–182 refs (See N68-19653 10-05)

Reported are the following studies: (1) *Theoretical Radiation Physics*—plasma excitation, dipole moment requirements for electron attachment, electron scattering from atoms, electron emission, potential energy curves for diatomic molecules, etc; (2) *Interaction of Radiation with Liquids and Solids*—photon excitation and optical properties, refractive indices and reflectance measurements, and photoemission of silver, palladium, and nickel in vacuum ultraviolet; (3) *Atomic and Molecular Radiation Physics*—molecular scattering and electron capture, ion lifetimes and resonances, negative ion-molecule reactions, etc.; (4) *Graduate Education and Vocational Training;* and (5) *Physics of Tissue Damage*—electron transmission in solids, amino acid excitations, radiation interactions with liquids, organic scintillators, electron excitation of volume plasmas, and excitation and ionization in aluminum. G.G.

N68-19663# Atomics International, Canoga Park, Calif.
DISCRETE ORDINATES REPRESENTATIONS OF THE SCATTERING KERNEL
B. D. O'Reilly and R. C. Lewis 30 Nov. 1967 20 p refs
(Contract AT(04-3)-701)
(NAA-SR-12493) CFSTI: HC $3.00/MF $0.65

It is demonstrated that acceptably accurate DSN estimates of the slowing-down source can be obtained using a low-order truncation of the poorly convergent Legendre series expansion of the angle-energy transfer probability function, while very poor estimates can be expected when its angle-to-angle energy-to-energy representation is used. Author (NSA)

N68-19672# California Univ., Livermore. Lawrence Radiation Lab.
THEORY OF INJECTION OF RELATIVISTIC ELECTRONS INTO THE ASTRON
C. H. Woods May 1967 33 p refs
(Contract W-7405-ENG-48)
(UCRL-50288) CFSTI: HC $3.00/MF $0.65

The process of injecting and trapping relativistic electrons through the effect of an electromagnetic field generated by collective interaction is described in terms of nonoverlapping clouds of particles in μ space. Although the motion of each cloud is characterized by the Vlasov equation, it is shown that repeated injection of particles mixes a characteristic amount of empty space with the particles, and thereby increases the measurable entropy. Some examples of the injection process applicable to the Astron experiment are presented in two-dimensional phase space. Author (NSA)

N68-19677 European Organization for Nuclear Research, Geneva (Switzerland).
PASSIVE COMPENSATION OF LONGITUDINAL SPACE CHARGE EFFECTS IN CIRCULAR ACCELERATORS: THE HELICAL INSERT
A. M. Sessler and V. G. Vaccaro 15 Jan. 1968 29 p refs
(CERN-68-1)

The longitudinal electric field associated with a particle beam having azimuthal variation in charge density and moving within a helix which is surrounded by an outer sheath of arbitrary electrical properties, is investigated theoretically. It is shown that for density variations having a wavelength long compared to the helix radius, the magnitude and sign of the electric field may be set to any desired value, by appropriate choice of the helix and sheath parameters. In particular, conditions on the parameter of an helical insert of short circumferential length are given, for which there is complete compensation of the longitudinal space charge forces at one particle energy. The insert consists of a highly conducting helix surrounded by a ferrite sheath. Such a device should permit acceleration of a large line density, through the phase transition of an alternating gradient accelerator, without a decrease in longitudinal phase space density. Author

N68-19681# Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physikinstitut.
THE DETERMINATION OF THE RATIO C_A/C_V THROUGH ANALYSIS OF THE PROTON SPECTRUM DURING NEUTRON DECAY [ZUR BESTIMMUNG DES VERHAELTNISSES C_A/C_V DURCH MESSUNG DES PROTONENSPEKTRUMS BEIM NEUTRONENZERFALL]
Peter Riehs 1967 11 p refs In GERMAN; ENGLISH summary
Presented at the Ann. Austrian Physicists Soc. Conv., Innsbruck, 1967
(Contract AF 61(052)-857)
(SGAE-PH-56/1967)

The determination of the ratio C_A/C_V of beta decay coupling constants from neutron decay alone is considered in connection with a planned experiment. It appears most promising to determine the angular correlation between electron and antineutrino from the slope of the proton recoil spectrum, without coincidence

requirement. The deformation of the spectrum due to the thermal energies of neutrons and to the finite spectrometer resolution is estimated. Author

N68-19714# Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
PROCEEDINGS OF THE 7TH CRACOW SCHOOL OF THEORETICAL PHYSICS, VOLUME 2
Jun. 1967 147 p refs Lectures held in Kalathowki, Poland, Jun. 1967
(INP-555/PL/PH)

CONTENTS:

1. MULTIPARTICLE ANNIHILATIONS OF ANTIPROTONS IN HYDROGEN J. A. Danysz p 1–15 refs (See N68-19715 10-24)

2. ANGULAR CORRELATIONS IN ANTIPROTON–PROTON ANNIHILATIONS M. Szeptycka (Warsaw Univ.) and O. Czyzewski p 17–29 refs (See N68-19716 10-24)

3. ANNIHILATION AT REST FOR PROTON–ANTIPROTON DECAY K. Zalewski p 31–50 refs (See N68-19717 10-24)

4. HEAVY NUCLEON RESONANCES IN HIGH MULTIPLICITY INELASTIC COLLISIONS O. Czyzewski p 51–63 refs (See N68-19718 10-24)

5. A SIMPLE MODEL OF HIGH MULTIPLICITY, HIGH ENERGY INTERACTIONS G. Bialkowski (Warsaw Univ.) and R. Sosnowski p 65–73 ref (See N68-19719 10-24)

6. WHAT ARE FIRE BALLS? M. Miesonicz p 75–78 (See N68-19720 10-24)

7. THE THREE-BODY FINAL STATES IN KP INTERACTIONS A. Eskreys p 79–99 refs (See N68-19721 10-24)

8. ORBITAL ANGULAR MOMENTA AT HIGH-ENERGY INTERACTIONS AND THE VAN HOVE OVERLAP FUNCTION L. Michejda p 101–112 refs (See N68-19722 10-24)

9. SCATTERING OF VERY HIGH ENERGY PARTICLES FROM LIGHT NUCLEI W. Czyz p 113–115 refs (See N68-19723 10-24)

10. IS A HYPERISOMER OF $^{7}_{\Lambda}$Li POSSIBLE? J. Pniewski, Z. Szymanski (Warsaw Univ.), D. H. Davis (Univ. Coll., London (Engl.)), and J. Sacton (Brussels Univ.) p 117–122 refs (See N68-19724 10-24)

11. ONE-PARTICLE ASPECTS OF THE FISSION PROCESS Z. Szymanski and S. Wychech p 123–124 ref (See N68-19725 10-24)

12. THE ANHARMONIC EFFECTS AND APPEARANCE OF THE NUCLEAR DEFORMATION IN EVEN–EVEN NUCLEI R. V. Jolos p 125–136 refs (See N68-19726 10-24)

13. SIMPLE MICROSCOPIC MODEL OF ATOMIC NUCLEI D. A. Kirzhnits p 137–145 (See N68-19727 10-24)

14. RESIDUAL INTERACTION IN NUCLEI Z. Bochnacki p 147–153 (See N68-19728 10-24)

15. ISOBARIC ANALOGUE RESONANCES IN HEAVY NUCLEI AND COULOMB DISPLACEMENT ENERGIES N. Marquardt p 155–161 refs (See N68-19729 10-24)

16. "NEUTRON"–NEUTRONHOLE STATES IN ^{140}Ce A. Heusler p 163–165 refs (See N68-19730 10-24)

N68-19715# Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
MULTIPARTICLE ANNIHILATIONS OF ANTIPROTONS IN HYDROGEN
J. A. Danysz *In its* Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 1–15 refs (See N68-19714 10-24)

The processes of annihilation of antiprotons are discussed, and several examples are included in which the annihilations resulting in the production of many particles in the final state are interpreted as three-particle reactions. The statistical model of Fermi, the quark model, the model of Koba–Takeda, and other theoretical models are considered for describing the annihilation process. The Koba–Takeda and a baryon exchange model appear to be the best approaches, although both of these have to be modified to account for resonance production. M.W.R.

N68-19716# Polish Academy of Sciences, Cracow. Inst. of Nuclear Research.
ON THE ENERGY DEPENDENCE OF THE EFFECT OF ANGULAR CORRELATIONS IN ANTIPROTON–PROTON ANNIHILATIONS
Oleg Czyzewski and Maria Szeptycka (Warsaw Univ.) *In its* Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 17–29 refs (See N68-19714 10-24)

Dependence of the angular correlations of antiproton–proton annihilations on average pion energy was found to be of exponential form. A strong energy dependence was observed for the differences between the opening angle distributions for the like and unlike charge pion pairs, and an empirical formula is proposed for describing differences between the annhilation channels. A model designated for GGLP does not agree with the discussed data because it does not account for resonance production. M.W.R.

N68-19717# Polish Academy of Sciences, Cracow. Inst. of Physical Chemistry.
ANGULAR CORRELATION BETWEEN PIONS IN ANNIHILATION AT REST FOR PROTON–ANTIPROTON DECAY
Kacper Zalewski *In its* Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 31–50 refs (See N68-19714 10-24)

Four-prong proton–antiproton annihilation studies of Goldhaber indicated that in the center of the mass system angular distributions of pions of opposite charges were of more peaked background and that for identical charges was more isotropic than predicted by the statistical model. If this explanation is accepted, then the one-particle amplitudes in momentum space can be different for identical particles and the phases of these differences are rapidly varying functions of the momenta of positive pions. In addition to the model proposed by Goldhaber, an uncorrelated jet model is discussed for determining angular distributions during annihilation reactions. M.W.R.

N68-19718# Polish Academy of Sciences, Cracow. Inst. of Nuclear Research.
HEAVY NUCLEON RESONANCES IN HIGH MULTIPLICITY INELASTIC COLLISIONS
Oleg Czyzewski *In its* Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 51–63 refs (See N68-19714 10-24)

Formation of heavy nucleon isobars in high multiplicity processes is discussed, and two kinds of production experiments are presented whereby these nucleon isobars can be observed. Nucleon isobars of 3/2 isospin and positive parity and T=1/2 isobars were systematized in terms of Regge recurrences, and various tables illustrate these results as well as some effective mass distributions. M.W.R.

N68-19719# Warsaw Univ. (Poland). Inst. of Theoretical Physics.
A SIMPLE MODEL OF HIGH MULTIPLICITY, HIGH ENERGY INTERACTIONS
G. Bialkowski and R. Sosnowski (Polish Acad. of Sci., Warsaw) *In* Polish Acad. of Sci. Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 65–73 ref (See N68-19714 10-24)

Some features of high energy, high multiplicity interactions are discussed on the basis of six-prong interactions of 8 GeV/c positive pions and protons. The four momentum transfer distribution of the proton is described, and experimental data are considered in terms of a simple statistical model. The distribution of protons and baryons for two-body and many-body reactions exhibit the same general behavior if the phase space factor is taken into account. M.W.R.

N68-19720# Polish Academy of Sciences, Cracow. Inst. of Nuclear Research.
WHAT ARE FIRE BALLS?
M. Miesowicz *In its* Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 75–78 (See N68-19714 10-24)

An overview is presented of the asymmetric events in interactions of nucleons with energies between 200 and 300 GeV that were observed by cloud chamber and ionization calorimeters. A model is included for describing such events or fireballs that follow either the incident or target nucleon. Properties of these fireballs are considered briefly, and it is noted that their baryon number is zero and that the energy spectrum of their pions is of the Boltzmann type. The possibility that such events are of a peripheral nature is suggested. M.W.R.

N68-19721# Polish Academy of Sciences, Cracow. Inst. of Nuclear Research.
THE THREE-BODY FINAL STATES IN KP INTERACTIONS
A. Eskreys *In its* Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 79–99 refs (See N68-19714 10-24)

Kaon–pion interactions are considered at 2.0 to 10.0 GeV of the incident kaon energy, and emphasis is placed on the actual interaction mechanism. An appreciable amount of three-body states is suggested for such interactions, and qualitative features of these reactions support the idea of double peripheral model to explain the final states. Momentum dependence of cross sections for three-body reactions are illustrated, as are scattering angle distributions. M.W.R.

N68-19722# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
ORBITAL ANGULAR MOMENTA AT HIGH-ENERGY INTERACTIONS AND THE VAN HOVE OVERLAP FUNCTION
L. Michejda *In* Polish Acad. of Sci. Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 101–112 refs (See N68-19714 10-24)

Pion–proton interactions at 8 GeV/c were studied to determine the orbital angular momenta produced by high energy interactions, and the resultant data are considered applicable to any pair of strongly interacting particles. Distributions of partial inelastic cross sections are shown, and overlap functions are illustrated for the four-body and six-body final states and for various inelastic final states of many-body problems. Measurements of the differential cross sections of electrons and nucleons scattered elastically from helium 4 were used in the study. M.W.R.

N68-19723# Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
SCATTERING OF VERY HIGH ENERGY PARTICLES FROM LIGHT NUCLEI
W. Czyz *In its* Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 113–115 refs (See N68-19714 10-24)

Recent experimental results on scattering of nucleons and electrons from nuclei are interpreted based on the Glauber model for high energy multiple scattering of particles from complex targets, and mention is made of elastic scattering from helium 4. Distinction is made between a nuclear structure and an elementary particle aspect of such investigations, and it is suggested that the spin dependences of the elementary process amplitudes may be resolved by the multiple scattering contributions. M.W.R.

N68-19724# Warsaw Univ. (Poland).
IS A HYPERISOMER OF ^{7}Li POSSIBLE?
J. Pniewski, Z. Szymanski, D. H. Davis (Univ. Coll., London Engl.), and J. Sacton (Brussels Univ.) *In* Polish Acad. of Sci. Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 117–122 refs (See N68-19714 10-24)

Consideration is given to the possibility of a lithium 7 hyperon isomer as the cause for low binding energy hyperon events. Results are given for pure LS coupling of the core nucleus with spin-spin, tensor, and spin-orbit forces; and the splitting of low levels of lithium 6 is illustrated. The energy of the positive 5/2 level in lithium 7 and the existence of an isomeric state may depend largely on the presence of tensor and spin-orbit forces of a hyperon particle with nucleons. M.W.R.

N68-19725# Polish Academy of Sciences, Warsaw. Inst. for Nuclear Research.
ONE-PARTICLE ASPECTS OF THE FISSION PROCESS
Z. Szymanski and S. Wycech *In* Polish Acad. of Sci. Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 123–124 refs (See N68-19714 10-24)

Individual nucleon motion in an average nuclear potential is assumed for the calculation of nuclear fission properties, and preliminary calculations of energy as a function of deformation were performed for a soluble model of an anisotropic harmonic oscillator as well as for a average nuclear field with Nilsson potential and including hexadecapole deformation. The one-particle aspects of fission are considered. M.W.R.

N68-19726# Joint Inst. for Nuclear Research, Dubna (USSR).
THE ANHARMONIC EFFECTS AND APPEARANCE OF THE NUCLEAR DEFORMATION IN EVEN-EVEN NUCLEI
R. V. Jolos *In* Polish Acad. of Sci. Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 125–136 refs (See N68-19714 10-24)

A Hartree–Fock approximation is used in a method presented for finding nuclear energy as a function of deformation parameters, although this approximation gives good results only near the point of the equilibrium deformation and it cannot be used in the case of perturbation theory. Potential energy of the nuclear deformation is found to be a bounded function of the deformation parameters in contrast to that of the harmonic oscillator potential. M.W.R.

N68-19727# Academy of Sciences (USSR), Moscow.
SIMPLE MICROSCOPIC MODEL OF ATOMIC NUCLEI
D. A. Kirzhnits *In* Polish Acad. of Sci. Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 137–145 In RUSSIAN (See N68-19714 10-24)

A simple method of describing various properties of atomic nuclei and simple nuclear reactions is presented. The mathematical model, based on an empirical observation of pair production in potential interactions between isolated nuclei, does not depend upon phenomenological parameters. This model simply presents a physical picture of nuclear interactions in atomic nuclei by using uncomplicated mathematical techniques. Transl. by E.J.S.

N68-19728# Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
RESIDUAL INTERACTION IN NUCLEI
Z. Bochnacki *In its* Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 147–153 (See N68-19714 10-24)

Reaction matrix is discussed as the residual interaction operator and the effective forces for diagonalization within one shell, and the field producing part of the effective interaction is identified. It is noted that the residual interaction differs significantly from the free nucleon interaction. M.W.R.

N68-19729# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).
ISOBARIC ANALOGUE RESONANCES IN HEAVY NUCLEI AND COULOMB DISPLACEMENT ENERGIES
N. Marquardt *In* Polish Acad. of Sci. Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 155–161 refs (See N68-19714 10-24)

An expression is given to describe the isobaric analog state, which is a superposition of scattering states and two-particle, one-hole states. A fit of the excitation functions for elastic scattering from about 8 to 12 MeV and for six angles was possible under isolated resonances, by employing coherent superposition, no spin-flip of the proton is caused by the background amplitude of the collision matrix, and the weakly energy dependent potential scattering amplitude is specified. An unsuccessful attempt was made to find an odd–even effect in heavy nuclei as a result of the pairing energy of two protons. A preliminary value for a deformation parameter was found for the Neodymium 150 (p,p_0) reaction.
M.W.R.

N68-19730# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).
"NEUTRON"–NEUTRONHOLE STATES IN ^{140}Ce
A. Heusler *In* Polish Acad. of Sci. Proc. of the 7th Cracow School of Theoret. Phys., Vol. 2 Jun. 1967 p 163–165 refs (See N68-19714 10-24)

All well isolated resonances in promethium 141 that are isobaric analogs to low-lying states in cerium 141 contain few but strong inelastic proton widths into the so-called neutron–neutronhole states in cerium 140. Equations are given for the differential cross sections and for writing the elements of the matrix. Influence of the residual interaction on the excitation energies shows only small effects.
M.W.R.

N68-19733 New York Univ., N. Y.
A STUDY OF THE DIFFUSION OF THERMAL NEUTRONS IN HETEROGENEOUS GRAPHITE-CADMIUM ASSEMBLIES BY THE PULSED NEUTRON SOURCE TECHNIQUE
Jacobus G. Mohr (Ph.D. Thesis) 1966 302 p Sponsored by AEC
Available from Univ. Microfilms: HC $13.75/MF $3.90 Order No. 67-4832

The inverse mean lifetime of thermal neutrons was experimentally determined in seven GBF graphite parallelepipeds, with geometric bucklings ranging between 0.00492 and 0.0115 cm^{-2}, by measuring the decay in time of the equilibrium thermal neutron field following the injection of a short pulse of fast neutrons into an assembly. The observed values compared well with calculations based upon published values of the diffusion parameters of GBF graphite. The experimentally observed decay constants of the perturbed assemblies were translated into equivalent geometric bucklings, and compared with theoretical predictions. The Nordheim–Scalettar method of treating black absorbers, in the formalism of Sinyutin and Semenov, was found to predict the observed bucklings successfully.
Dissert. Abstr.

N68-19751*# National Aeronautics and Space Administration. Washington, D. C.
EMISSION OF PHOTONS AND ELECTRON POSITRON PAIRS IN A MAGNETIC FIELD [IZLUCHENIYE FOTONOV I ELEKTRONNO-POZITRONNYKH PAR V MAGNITNOM POLE]
N. P. Klepikov Mar. 1968 23 p refs Transl. into ENGLISH from Zh. Eksperim. Teor. Fiz. (Moscow), v. 26, no. 1, 1954 p 19–34
(NASA-TT-F-11618) CFSTI: HC $3.00/MF $0.65 CSCL 20H

This article is a study of the luminous electron, electron-positron pair production, and single-photon annihilation of pairs in a strong magnetic field from the standpoint of relativistic quantum theory. Stationary wave functions are derived and the probability of particle transformations in a magnetic field is examined. Asymptotic equations are derived. The emission spectrum of the luminous electron is examined with consideration of the electromagnetic field as a perturbation. The probabilities of single-photon and two-photon annihilation of electron-positron pairs are compared. Transformations of a photon to an electron-positron pair and of electrons to electron-photon pairs are discussed.
Author

N68-19756# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
THE PROBLEM OF TWO BODIES INTERACTING WITH A NON-LOCAL FACTORIZING POTENTIAL [ZADACHA DVUKH TEL, VZAIMODEISTVUYUSHCHIKH S NELOKAL'NYM FAKTORIZUYUSHCHIMSYA POTENTSIALOM]
F. Tkebuchava and G. A. Chilashvili 1967 18 p refs In RUSSIAN
(JINR-P2-3404)

Factorizing potentials, which can raise the repulsion at small distances, are considered. The phase-shift analysis is performed in the case of interaction when, except for the Yukawa attraction, there exists a potential wall. The parameter values are found for this interaction which well describe the experimental data.
Author (NSA)

N68-19757# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
METHOD OF DATA PROCESSING OF TWO-DIMENSIONAL COINCIDENCE SPECTRA AND ITS APPLICATION FOR THE ANALYSIS OF γ–γ COINCIDENCE SPECTRA MEASURED IN ^{155}Tb WITH Ge(Li) DETECTORS [METOD OBRABOTKI DVUKHMERNYKH SPEKTROV SOVPADENII I EGO PRIMENENIE K ANALIZU γ–γ SOVPADENII NA Ge(Li) DETEKTORAKH PRI RASPADE ^{155}Tb]
P. Galan, M. Ya. Kuznetsova, M. Finger, and I. Yursik 1967 46 p refs In RUSSIAN
(JINR-P6-3479)

The method of data processing of two-dimensional coincidence spectra is described and its application for the γ–γ coincidence spectra analysis in ^{155}Tb is shown. The existence of levels with energies 86.5; 105.3; 118.0; 235.2; 266.6; 268.6; 286.8; 326.0; 377.7; 427.4; 451.3, and 488.8 keV in the ^{155}Gd nucleus is proved on the basis of γ–γ coincidences measured in ^{155}Tb decay with Ge(Li) detectors. Two new transitions with energies of $\approx$192 and $\approx$163 keV were found.
Author (NSA)

N68-19762 Michigan Univ., Ann Arbor.
PROTON-DEUTERON ELASTIC SCATTERING AT HIGH MOMENTUM TRANSFERS
Ernest Coleman (Ph.D. Thesis) 1966 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-1717

An experimental and theoretical investigation of proton-deuteron elastic scattering at high momentum transfers is presented. The differential cross sections for backward elastic scattering at incident proton kinetic energies of 1.0, 1.3, and 1.5 GeV have been measured for four-momentum transfer squared $(-t)$ from 2.6 to 5.0 $(GeV/c)^2$, which corresponds to cosine of center-of-mass proton scattering angles $(\cos\theta^*)$ from -0.5 to -0.9. A backward peak is observed, and the slope and magnitude of the peak have been determined. The one-nucleon exchange peripheral model has been successful in interpreting the backward peak. Calculations based on modern three-body quantum mechanical formalisms for the three-nucleon system supporting a two-body bound state also suggest the one-nucleon exchange process as the dominant mechanism. The measured forward differential cross section has been explained by the importance of double-scattering of the incident proton at higher momentum transfers.
Dissert. Abstr.

N68-19763 Cornell Univ., Ithaca, N. Y.
MEASUREMENTS OF THE NEUTRON ELECTROMAGNETIC FORM FACTORS

Morris Edward Binkley, Jr. (Ph.D. Thesis) 1966 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-1496

Investigations have been made of the electromagnetic neutron form factors at momentum transfers of 5.5 F^{-2}, 10.0 F^{-2}, and 14.5 F^{-2} by measuring the differential cross sections for quasi-elastically scattered electrons by deuterium in coincidence with a scattered nucleon in the reaction e+d→e+p+n. This was done by measuring the ratio of the differential cross section $d^3\sigma/dE_e d\Omega_e d\Omega_n$ to the differential cross section $d^3\sigma/dE_e d\Omega_e e\Omega_p$ for two different electron scattering angles for each value of the momentum transfer q^2. The most important result is for G_{en}^2 since its value is very insensitive to the absolute efficiency and solid angle of the neutron counter. For all three momentum transfers we obtained results consistent with $G_{en}^2 = 0$. Dissert. Abstr.

N68-19766# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
DIPS IN THE C=−1 EXCHANGE CONTRIBUTION OF TWO-BODY INELASTIC PROCESSES. 2: KN→KN AND B-CONSPIRACY
A. P. Contogouris, J. Tran Thanh Van, and H. J. Lubatti (Lab. de l'Accelerateur Lineari) Jan. 1968 13 p refs
(Rept.-68/4) CFSTI: HC $3.00/MF $0.65

The Regge theory predictions on the momentum transfer dependence are studied for a specific combination of KN→K_{890}N differential cross sections which isolates the C=−1 exchange contribution. A way to obtain information on the B-exchange is presented and a forward dip, which is actually observed, in connection with a possible B-conspiracy (of type II or III in the classification of the group O(4)) is discussed. Author

N68-19820# National Bureau of Standards, Washington, D. C.
X-RAY WAVELENGTHS AND X-RAY ATOMIC ENERGY LEVELS
J. A. Bearden (Johns Hopkins Univ.) Washington GPO Repr. from Rev. Modern Phys., v. 31, no. 1, Jan. 1967 74 p refs
(NSRDS-NBS-14) GPO: $0.40

CONTENTS:

1. X-RAY WAVELENGTHS J. A. Bearden (Johns Hopkins Univ.) p 1–47 refs (See N68-19821 10-24)
2. REEVALUATION OF X-RAY ATOMIC ENERGY LEVELS J. A. Bearden and A. F. Burr (Johns Hopkins Univ.) p 49–66 refs (See N68-19822 10-24)

N68-19821# Johns Hopkins Univ., Baltimore, Md.
X-RAY WAVELENGTHS
J. A. Bearden *In* Natl. Bur. of Std. X-ray Wavelengths and X-ray Atomic Energy Levels Jan. 1967 p 1–47 refs Sponsored by National Bureau of Standards and NSF (See N68-19820 10-24)

Factors supporting the selection of the W $K\alpha_1$ line as the X-Ray Wavelength Standard are critically discussed. A review is given of the experimental measurements which are used to establish the wavelength of this line on an absolute angstrom basis. Its value is λ W $K\alpha_1$=(0.2090100±5 ppm) Å. This may be used to define a new unit, denoted by Å*, such that the W $K\alpha_1$ wavelength is exactly 0.2090100 Å*; hence 1Å* = 1Å±5 ppm. The wavelengths of the Ag $K\alpha_1$, Mo $K\alpha_1$, Cu$K\alpha_1$, and the Cr $K\alpha_2$ have been established as secondary standards with probable error of approximately one part per million. Sixty-one additional X-ray lines have been used as reference values in a comprehensive review and reevaluation of more than 2700 emission and absorption wavelengths. The recommended wavelength values are listed in Å* units together with probable errors; corresponding energies are given in keV. A second table lists the wavelengths in numerical order, and likewise includes their energies in keV. Author

N68-19822# Johns Hopkins Univ., Baltimore, Md.
REEVALUATION OF X-RAY ATOMIC ENERGY LEVELS
J. A. Bearden and A. F. Burr *In* Natl. Bur. of Std. X-ray Wavelengths and X-ray Atomic Energy Levels Jan. 1967 p 49–66 refs Sponsored by National Bureau of Standards, AEC, and NSF (See N68-19820 10-24)

All of the X-ray emission wavelengths have recently been reevaluated and placed on a consistent Å scale. For most elements these data give a highly overdetermined set of equations for energy level differences, which have been solved by least-squares adjustment for each case. This procedure makes best use of all X-ray wavelength data, and also permits calculation of the probable error for each energy difference. Photoelectron measurements of absolute energy levels are more precise than X-ray absorption edge data. These have been used to establish the absolute scale for elements and, in many cases, to provide additional energy level difference data. The X-ray absorption wavelengths were used for eight elements and ionization measurements for two; the remaining five were interpolated by a Moseley diagram involving the output values of energy levels from adjacent elements. Probable errors are listed on an absolute energy basis. Author

N68-19849 California Univ., Los Angeles.
SUPEREXCHANGE INTERACTION BETWEEN MAGNETIC ION PAIRS AND SUPER TRANSFERRED HYPERFINE INTERACTION IN WEAKLY COVALENT CRYSTALS
Nai Li Huang (Ph.D. Thesis) 1966 180 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-0912

The Dirac–Van Vleck–Serber's method of configuration interaction is extended and systematized in order to handle the interaction between transition metal ions. Specific applications are made to the following problems: 1) exchange interaction between nearest V^{2+} neighbors in $KMgF_3$ (collinear superexchange); 2) exchange interaction between nearest V^{2+} neighbors in MgO (right angle superexchange); and 3) superexchange interaction between next nearest V^{2+} and Ni^{2+} neighbors in MgO (exchange between inequivalent ions). The change in hyperfine field at a magnetic cation site due to cation–cation interaction is also calculated. Dissert. Abstr.

N68-19871 California Univ., Davis.
BETA-GAMMA (CIRCULARLY POLARIZED) CORRELATION AND GAMMA-SPECTROSCOPIC STUDIES ON Mg^{27}
Robert Allen Bigoni (Ph.D. Thesis) 1966 53 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-5232

Studies were made of the circular-polarization of the two high-energy γ-rays (1.01 Mev and 0.84 Mev) following the two-branch β^--decay of Mg^{27} to Al^{27}. The photon spin polarization is a result of its being detected in coincidence with an immediately preceding β-particle which possesses, in the relativistic limit, 100% longitudinal polarization by virtue of the complete breakdown of parity in β-decay. The γ-ray polarization measurements were done with γ-polarimeters based on the principle of the dependence of the Compton scattering cross-section on the relative orientation of electron spin and photon spin. The measured A values are, A(1.59, 1.01) = −.056±.054, A(1.75, 0.84) = −.258±.026 where A is written as a function of the coincident particle energies, i.e., A=A(E_β, E_γ). Dissert. Abstr.

N68-19878 Washington Univ., Seattle.
SPIN-DEPENDENT EFFECTS ON THE DIFFERENTIAL CROSS SECTION AND POLARIZATION FOR THE (α,N) REACTION
Timothy G. Kelley (Ph.D. Thesis) 1966 158 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-7654

A study is made of the effects of spin dependent forces on direct reaction cross sections and polarizations, with special emphasis placed on the (α, nucleon) reaction. The investigation is specifically concerned with the dependences of the cross section and polarization on (1) the spin-orbit potential for the outgoing nucleons, (2) the spin dependence and structure of the interaction causing the reaction, and (3) the orbital-spin angular momentum coupling of the captured particles (J-dependences). Substantial J-dependences in the computed (α,N) cross sections are found even at forward scattering angles, and arguments are presented that support the spectroscopic reliability of these results, utilizing a modified diffraction model. The diffraction model is used also to provide considerable understanding of several angular momentum-dependent features of the computed polarizations. Dissert. Abstr.

N68-19899# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
RELATIVISTIC ION IN ELECTROMAGNETIC WAVE (BATTELLE-NORTHWEST PROGRAM ORBIT)
Bernard H. Duane Jun. 1967 44 p refs
(Contract AT(45-1)-1830)
(BNWL-452) CFSTI: HC $3.00/MF $0.65

Battelle-Northwest program Orbit constructs and plots eight-dimensional phase-space orbits for a relativistic charged particle driven by an electromagnetic plane wave. Author (NSA)

N68-19906# Idaho Nuclear Corp., Idaho Falls.
INVERSION OF THE LEVEL MATRIX IN R-MATRIX THEORY BY THE METHOD OF RANK ANNIHILATION
T. Watanabe Aug. 1967 36 p refs
(Contract AT(10-1)-1230)
(IN-1098) CFSTI: HC $3.00/MF $0.65

The level-matrix approach to the problem of matrix inversion in R-matrix theory still requires inverting the level matrix if the collision matrix is to be used for calculating cross sections. It is shown that the method of rank annihilation inverts the level matrix in analytical form for the general case. The general results are then specialized to the cases of two and three channels, and the expressions for the scattering and fission cross sections are obtained. Although the results of the specialized treatment are applied to the two-level situation, the relevant expressions are in a form that allows a generalization to any number of levels (channels are still restricted to 2 and 3 in number). The approximations, which can be made to simplify the reduced widths and which can eliminate off-diagonal channels as well as the application of these modifications, will be discussed. Author (NSA)

N68-19912 California Univ., Berkeley.
FISSION PROPERTIES OF SOME ELEMENTS BELOW RADIUM
Arastoo Khodai-Joopari (Ph.D. Thesis) 1966 200 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-5093

The fission cross sections σ_f have been measured in bombardments of Bi^{209}, Pb^{208}, Pb^{207}, and Pb^{206} with helium ions of energies 25–130 MeV and Bi^{209}, Pb^{208}, Pb^{206}, and Au^{197} with protons of energy 15–30 MeV, using mica for the detection of fission fragments. From the comparison of the low-energy σ_f/σ_R data with three different theoretical expressions for Γ_f/Γ_n, the heights of the fission barriers, B_f for At^{213}, Po^{212}, Po^{210}, Bi^{209}, Bi^{207}, and Hg^{198} have been deduced. The accuracies of the relative and the absolute values of B_f are 0.5 and 1.5 MeV, respectively. It is found that the ratio a_f/a_n is quite different (1.5 to 1.2) for these nuclei, indicating that the influence of shell effects on the level densities is still strong at moderately high excitation energies (≈16–40 MeV). A discussion is given of the possibility that shell effects at the saddle point may affect the interpretation of the observed features of low- and medium-energy fission, along with a brief review of some of the experimental and theoretical findings. Dissert. Abstr.

N68-19921 Illinois Univ., Urbana.
SOME TWO BODY FINAL STATES OF K^-p INTERACTIONS AT 1.328 GEV/C
William Peter Trower (Ph.D. Thesis) 1966 127 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-6758

We studied 21,187 two-prong, two-prong-kink and zero-prong-V events at an incident kaon momentum of 1.328 GeV/c using the Lawrence Radiation Laboratory's 72-inch hydrogen bubble chamber and the Scanning-Measuring Projector (SMP). We determined the total and partial cross sections and where possible the production and polarization angular distributions of the final states $K^-p \rightarrow K^-p$; $K^-p \rightarrow \Sigma^-\pi^+$, $\rightarrow \bar{K}^0 n$, $\rightarrow \Sigma^0\pi^0$, $\rightarrow \Lambda\pi^0$, $\rightarrow K^+\Xi^-$, $\rightarrow \Sigma^+\pi^-$, $\rightarrow \eta\Lambda$. The angular distributions are discussed in terms of known resonances. Diffraction model fits are made to the elastic scattering data. Dissert. Abstr.

N68-19948 Florida State Univ., Tallahassee.
CHARGE DISTRIBUTION IN THE FISSION OF Th^{232}
Sheldon Henry Freid (Ph.D. Thesis) 1966 81 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-5522

A radiochemical investigation of the charge distribution in the 9.5 MeV, 11.3 MeV proton and 11.5 MeV deuteron induced fission of Th^{232} was performed. Irradiations of thorium metal foils were carried out on Van de Graaff Accelerator and ten shielded and quasi-shielded nuclides were studied at each energy. The fractional yields of each of the nuclides were correlated with Z_p values derived on the basis of the ECD, MPE, and UCD prescriptions using both shell and non shell affected mass equations. Hydrazinolysis left only lysine as an intact amino acid. Its carboxyl is therefore free and neither glycine nor the alpha glutamyl carboxyl is free. The probable significance of the epsilon-amino lysine link in protein structure is discussed. Dissert. Abstr.

N68-19950# California Univ., Livermore. Lawrence Radiation Lab.
EXCITATION FUNCTION OF THE REACTIONS $^{147}Sm(D,2N)^{147}Eu$ BELOW 12 MEV
Jacques B. J. Read 27 Oct. 1967 7 p refs
(Contract W-7405-ENG-48)
(UCRL-50332) CFSTI: HC $3.00/MF $0.65

Using a stacked foil technique, the $^{147}Sm(d,2n)^{147}Eu$ excitation function was determined from 7.6 to 12.0 MeV. Upper limits only were estimated at 5.6 and 6.6 MeV. Over 50 photopeaks were seen in the spectra of the targets. Of these, two were easily resolved at 198 and 602 keV and were due to ^{147}Eu decays. The excitation function indicates the existence of an intermediate structure peak at an incident deuteron energy of 9.5 MeV. Author (NSA)

N68-19986# Mound Lab., Miamisburg, Ohio.
NEUTRON ENERGY SPECTRA OF ^{239}Pu–Be, ^{238}Pu–F, AND ^{238}Pu–$^{18}O(\alpha,n)$ SOURCES
M. E. Anderson 31 Oct. 1967 12 p
(Contract AT(33-1)-GEN-53)
(MLM-1422) CFSTI: HC $3.00/MF $0.65

The energy spectra of isotopic neutron sources are being determined with a single stilbene crystal, fast neutron spectrometer. Pulse shape discrimination is used to separate pulses originating from neutron interaction and those originating from gamma interactions. Spectra were obtained for (α,n) sources containing ^{239}Pu with Be, ^{238}Pu with F, and ^{238}Pu with ^{18}O. Author (NSA)

N68-19979# RAND Corp., Santa Monica, Calif.
FLUX EQUIVALENCES AMONG RAYLEIGH, ISOTROPIC, AND OTHER SCATTERING MODELS
H. Kagiwada, R. Kalaba, and R. Segerblom Jan. 1968 38 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5537-PR; AD-664904)

High-precision numerical methods are used to find the transmitted and reflected fluxes for conservative isotropic scattering and Rayleigh scattering, for a wide range of slab thicknesses. Idealized models are then used to derive simple analytical expressions. These expressions are evaluated numerically, and the results are compared against the earlier calculations. The fluxes from all models are in excellent agreement with the high-precision calculations for all optical thicknesses from zero to fifty, indicating that the formulas derived provide very good approximations to the diffusely reflected fluxes. It is also shown that the external fluxes are virtually independent of the nature of the local scattering law for the cases considered. TAB

N68-19990# Gulf General Atomic, San Diego, Calif.
EXPERIMENTAL AND THEORETICAL STUDY OF LATTICE DYNAMICS Final Report, 19 Sep. 1966–18 Sep. 1967
G. M. Borgonovi Sep. 1967 104 p refs
(Contract F19628-67-C-0080)
(GA-8259; AFCRL-67-0589; AD-664942)

The possibility of making studies of lattice dynamics using a linear electron accelerator as a neutron source has been investigated. The methods of filter analyzer and crystal analyzer have been studied both experimentally and theoretically. The single differential angular cross sections were measured and results were compared to a calculation made on the basis of a lattice dynamical model. Experiments on aluminum show that this method is inherently sensitive enough to allow the check of a lattice dynamical model. Sharp peaks arise in the angular cross section whenever the velocity of the scattered neutron is equal to the phase velocity of the phonon responsible for the scattering process. A lattice dynamical model has been produced for the system MgO. The calculation is based on the formalism of the shell model with noncentral interactions extended to second neighbors. The parameters are derived from the known elastic and dielectric constants. The full dispersion relations for symmetry directions, the frequency spectrum, and the specific heat of MgO have been calculated. TAB

N68-19992# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
OLD BARNYARD: A CROSS SECTION CODE FOR SCHOOL USE
Charles J. Bridgman, Daniel P. Cannon, Ernest P. Sims, and Robert H. Hansen Dec. 1967 150 p refs Supersedes AFIT-TR-66-6, May 1966
(AFIT-TR-67-17; AFIT-TR-66-6; AD-664565)

OLD BARNYARD is a digital computer code which calculates few group fast and thermal neutron cross sections and constants. The first of two sequential chains calculates the neutron flux needed to determine the group cross sections. The code uses the moments method to find the fast flux and solves the Wilkins equation numerically for the thermal flux. The code is written in Fortran for a small computer, the IBM 1620, and is intended for use by students and professors in support of classroom assignments. Author (TAB)

N68-20018# Aerospace Corp., El Segundo, Calif. Space Physics Lab.
THE ATOMIC ABSORPTION CROSS SECTIONS OF LITHIUM AND SODIUM BETWEEN 600 AND 1000 Å, SUPPLEMENT 1: ATOMIC ABSORPTION CROSS SECTIONS OF SODIUM, 500 TO 600 Å
Robert D. Hudson and Virginia L. Carter Dec. 1967 [illegible]
(Contracts AF 04(695)-1001; F04695-67-C-0158)
(TR-1001(9260-01)-5, Sup. 1; SSD-TR-67-92, Sup. 1; AD-664742)

The continuous atomic absorption cross sections of neutral sodium vapor have been measured in the wavelength region between 500 and 700A. Best estimates of the cross sections and their errors as obtained from the results are presented in tabular form. Author (TAB)

N68-20097 Florida State Univ., Tallahassee.
DETERMINATION OF WAVE FUNCTIONS FOR THE 2 ^{1}S AND 2 ^{3}S STATES OF THE HELIUM ATOM AND THE STUDY OF SPATIAL CORRELATION IN THE 1 ^{1}S, 2 ^{1}S, AND 2 ^{3}S-STATES OF TWO ELECTRON ATOMS
James Patrick Tatum (Ph.D. Thesis) 1966 128 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-6485

Wave functions for the 2 ^{1}S and 2 ^{3}S states of the helium atom of six and twelve terms and of the same functional form used previously by Hylleraas and Undheim and Traub and Foley have been determined. In a detailed study of the angular correlation properties of wave functions for the 1 ^{1}S state of helium, using a wave function previously determined by Chandrasekhar and Herzberg, and the 2 ^{1}S state of helium, it was discovered that certain terms in the wave function gave very poor representations of the spatial properties of the 2 ^{1}S state of helium for large interelectronic distances. This shortcoming of some wave functions is believed to lie in the variational procedure which was used to determine the wave function. A new variational principle was derived from Temple's formula for the lower bound to the energy of a given stationary state. A wave function determined from this variational procedure may give a more consistent representation of the spatial properties of the state under consideration. Dissert. Abstr.

N68-20105# Argonne National Lab., Ill.
THE CODES NURF, COMBO, AND TWOSORCE FOR PROCESSING FOIL COUNTING DATA
George S. Stanford Aug. 1967 87 p refs
(Contract W-31-109-ENG-38)
(ANL-7356) CFSTI: HC $3.00/MF $0.65

For the routine processing of foil counting data, the codes NURF and COMBO have been written in FORTRAN for the CDC-3600, providing a variety of input and processing options. A novel feature of the NURF code is its method for treating fission-product counting data. In making decay corrections for a set of fission foils, the traditional method has been to count simultaneously a reference foil that was irradiated along with the others. The NURF code permits one to dispense with the reference foil, provided that each foil of the set is counted several times. It converts the counting rates and elapsed times (after irradiation) to logarithms, and synthesizes a decay curve by means of a least-squares polynomial fit. This step is iteratively alternated with one in which the set of counts of each foil is multiplied by the factor that causes that set best to fit the previously found curve. The COMBO code is used in conjunction with NURF to perform further normalizing and combining tasks. The program is divided into two parts. The first part provides weighted averages when the same group of foils has been counted on more than one scaler, in more than one system, or at several different times. The second part is for use in internormalizing the data from an irradiated set of foils that has been separated into two or more groups, for counting on different channels, in different systems, or at different times. Each group must include one or more foils that are common to some other group. When counting rates are greater than approximately 4,000 per second, it has been desirable to measure the deadtime for each experiment. The TWOSORCE code facilitates the routine determination of the counting-channel resolving times, using the paired-source technique. Author (NSA)

N68-20138 New York Univ., N. Y.
COLLECTIVE OSCILLATIONS OF ATOMS IN THE HARTREE–FOCK APPROXIMATION
Solomon Wieder (Ph.D. Thesis) 1966 98 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-6062

The time-dependent Hartree approximation is used to find new atomic resonances that are not associated with single particle excitations. These resonances represent a collective oscillation of the atomic electrons. Using first order perturbation theory, we find a linear relationship between the fluctuation of the electron density and the perturbing radiation field. The perturbation is shown to consist of the applied field's potential plus a self-potential due to the fluctuation of the atomic electron density. A multipole expansion is used to relate the self-potential to the various induced multipole moments. Expressions are obtained relating to the response of these multipoles to a uniform oscillating electric field. The induced dipole moment is shown to contain a resonance at a collective frequency, ω_c. This resonance is associated with a collective vibration of the atomic electrons. Dissert. Abstr.

N68-20204# Yale Univ., New Haven, Conn. Gibbs Lab.
ANNUAL SUMMARY REPORT, JANUARY 1, 1967–DECEMBER 31, 1967
Vernon W. Hughes Jan. 1968 26 p refs
(Contract Nonr-609(53))
(AD-664668)

A source of polarized electrons was developed which will be useful for applications in high-energy physics as well as in low-energy atomic physics. A Mott scattering polarization detector, built for the electron-hydrogen scattering experiment, was combined with other available equipment to carry out this experiment on the collisional ionization of polarized metastable deuterium atoms. An experiment on the spin effects in electron-hydrogen scattering is being pursued. TAB

N68-20279 Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
RESONANCE PHENOMENA IN THE ELASTIC SCATTERING OF ALPHA PARTICLES ON ATOMIC NUCLEI [ZJAWISKA REZONANSOWE W SPREZYSTVM ROZPRASZANIU CZASTEK ALFA NA JADRACH ATOMOWYCH]
Lucjan Jarczyk 1967 139 p refs In POLISH; ENGLISH summary
(INP-577/PL) CFSTI: $3.00

A report of resonance phenomena in the elastic scattering of alpha particles on atomic nuclei is given. The experimental angular distributions of the differential cross-section for the elastic scattering of alpha particles on ^{39}K and ^{40}Ca nuclei in the energy range from 22 MeV to 29 MeV were analysed by means of the optical model. No satisfactory fits between the calculated and experimental results were obtained. The agreement could be considerably improved by modifying the phase shifts for the $l = 10$ partial waves. The resonances in the excitation curves indicate the possibility of the creation of highly excitated single-particle states with cluster structure in ^{43}Sc and ^{44}Ti nuclei. Author

N68-20294*# Maryland Univ., College Park. Physics and Astronomy Dept.
FOUNDATIONS OF A TWO-TEMPERATURE STATISTICAL MODEL
J. R. Wayland Feb. 1968 41 p refs
(Grant NsG-695)
(NASA-CR-93762; TR-803) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The recent secondary particle spectra from proton–proton interactions at machine energies were analyzed by the two-temperature statistical model of Wayland and Bowen to test for the independence of the longitudinal and transverse momentum (P_l and P_t, respectively). It was found that the assumption of independence of P_l and P_t is consistent with experiments. The variation of the longitudinal temperature with incident energy is considered in detail. The energy variation of the multiplicity of particles as a function of incident energy is found to be in agreement with cosmic ray results. The parameters for fitting particle spectra are given. Author

N68-20350# California Univ., Berkeley. Lawrence Radiation Lab.
PHYSICS DIVISION SEMIANNUAL REPORT, NOVEMBER 1966 THROUGH APRIL 1967
May 1967 113 p refs
(Contract W-7405-ENG-48)
(UCRL-17544) CFSTI: HC $3.00/MF $0.65

The research covered includes high-energy physics both experimental and theoretical, bubble chamber operation and development, computer programs, data processing and health physics. The operation and development of accelerators is also covered. NSA

N68-20409 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
VERY LOW MULTIPLICITY JETS IN TEV REGION AND THEIR INTERPRETATION IN TERMS OF NUCLEON ISOBARS [JETY BARDZO NISKIEJ KROTNOSCI PRZY ENERGII RZEDU TEV I ICH INTERPRETACJA PRZY POMOCY IZOBAROW NUKLEONOWYCH]
K. Rybicki 1967 8 p refs Submitted for publication
(INR-784/6/PH) CFSTI: $3.00

Six very low multiplicity interactions of high energy nuclei in nuclear emulsion are described. They are well interpreted in terms of single nucleon–nucleon collision in which the incident nucleon excites to the isobar state with mass of about 2 GeV/c^2. This isobar subsequently decays producing one to three particles. Author

N68-20438# International Centre for Theoretical Physics, Trieste (Italy).
SUPERCONVERGENT SUM RULE FOR PION PHOTOPRODUCTION ON LAMDA $^{0+}$
Prem P. Srivastava (Brazil Univ.) Mar. 1967 5 p refs Submitted for publication
(IC/67/19) CFSTI: HC $3.00/MF $0.65

The sum rules obtained for photoproduction of pions on nucleons are shown to be in agreement with the experimental data. From the Regge pole theory the high energy behavior of each interaction amplitude is assumed to be determined by the leading Regge trajectory. ESRO

N68-20439# International Centre for Theoretical Physics, Trieste (Italy).
COUPLING PROBLEM FOR U(p,q) LADDER REPRESENTATIONS. PART 2: LIMITATIONS ON THE COUPLING OF U(p,q) LADDERS
R. L. Anderson and R. Raczka (Inst. of Nucl. Res., Warsaw) Mar. 1967 12 p refs Submitted for publication Sponsored in part by NSF
(IC/67/10) CFSTI: HC $3.00/MF $0.65

It is shown that in the tensor product of two U(p,q) ladders there exists at most one ladder, which can then be associated with a third ladder to form a scalar. It is also proved that for any particle assignment of the physical multiplets to U(p,q) ladders representations consistent with the first order Casimir operator CI1B, the tensor product of two physical ladders does not contain any ladder. Therefore, it is impossible to construct an invariant Yukawa-type interaction term. ESRO

N68-20440# International Centre for Theoretical Physics, Trieste (Italy).

ON THE RE-ARRANGEMENT ENERGY OF THE NUCLEAR MANY-BODY PROBLEM

M. E. Grypeos Apr. 1967 14 p refs Submitted for publication
(IC/67/14) CFSTI: HC $3.00/MF $0.65

Mittelstaedt's definition of the re-arrangement energy, which is related to many-body calculations for the separation energy of a particle by means of model wave functions, is extended in a straightforward manner to the case in which a trial many-body wave function is used. The 'trial re-arrangement energy' so defined is studied in the case of the separation of a particle s from a system of A+1 particles in which the A particles (nucleons) are not identical to the s. In this treatment a Jastrow-like trial wave function is used. Some general properties of this trial re-arrangement energy are derived and the first term of its cluster expansion is given in the case in which the A nucleons form an infinite nuclear matter of density gr. Numerical estimates of this first order term are performed for a case of physical interest. Author (ESRO)

N68-20448# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

PROPERTIES OF THE 321 KEV 9/2 LEVEL IN ^{125}Te

J. Kownacki, J. Ludziejewski, and M. Moszynski 1967 7 p refs Submitted for publication
(Rept.-865/1A/PL) CFSTI: $3.00

The half-life of the 321 KeV 9−/2 level in ^{125}Te was determined with a time-to-amplitude converter to be /0.695±0.15/ns. The half-life limits of some higher lying states were established. The effect of the three quasiparticle nature of the 321 KeV level on the probability of the 176 KeV γ-transition deexciting this level is discussed. Author

N68-20459# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).

ON THE ADDITIVITY OF CONSERVED CHARGE OPERATORS

J. P. Leroy Feb. 1968 7 p refs
(TH-68/2)

It is shown that in any local field theory the charge associated with a conserved local current is additive. This result permits relation of the charge associated with the ρ-meson field to the isotopic charge operator as asserted by Kroll, Lee and Zumino. Author

N68-20482 Tokyo Univ. of Education (Japan). Dept. of Physics.

MASSES OF PSEUDOSCALAR MESONS AND THE ALGEBRA OF FIELDS

Syurei Iwao [1967] 5 p refs
CFSTI: $3.00

Masses of pseudoscalar mesons are discussed in terms of a Lagrangian. The spectral function is written so that a common mass contribution to all pseudoscalar mesons as well as the symmetry breaking effect are given. The pseudoscalar meson nonet is arranged in matrix form, and equations are given for determining masses of the mesons. M.W.R.

N68-20484*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PHOTOMESON-PRODUCTION BY THE UNIVERSAL MICROWAVE THERMAL RADIATION FIELD AND THE HIGH-ENERGY COSMIC RAY SPECTRUM

F. W. Stecker Feb. 1968 12 p refs
(NASA-TM-X-63145; X-641-68-69) CFSTI: HC $3.00/MF $0.65
CSCL 20H

A reexamination of the effect of photomeson-production by the universal microwave thermal radiation on the cosmic ray spectrum above 10^{11} GeV leads to the conclusion that the cosmic ray spectrum may not steepen abruptly above that energy as previously thought. The production of high energy mesons resulting from the interaction of cosmic-rays with low energy photons results in two effects of astrophysical interest. As was pointed out by Hayakawa, the resultant photoproduction of neutral pions yields gamma rays having energies greater than 10^8 GeV whose flux may be more intense than the gamma-ray flux from cosmic-ray proton–proton collisions. Author

N68-20512 Tata Inst. of Fundamental Research, Bombay (India).

RELAXATION OF AN INTERACTING SYSTEM OF RADIATION AND MATTER

J. Premanand and D. L. Falkoff (Brandeis Univ.) *In* Indian Inst. of Tech. Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 211–216 refs (See N68-20501 10-26)

A model of a two-state system interacting with radiation is presented for which the Pauli master equation is soluble. It is shown that the time-dependent solution can be obtained for the rate equation in the special case where one of the populations (either matter state populations or photon number) is maintained constant. Neutron scattering measurements in liquid gallium are reported, and the diffraction pattern is depicted. Also reported are observational data on Kohn anomalies in zinc. An assessment is made of the pseudo-potential methods of obtaining phonon dispersion relations for Be and Mg, and a method is proposed for describing the effect of a uniaxial stress on rotational energy levels of a molecule trapped in a solid. A neutron energy loss experiment on KH_2PO_4 was performed which shows that the proton vibration exists both in the paraelectric and ferroelectric phase in the frequency range 400 to 750 cm^{-1}. A comparison is drawn between the Lindemann and Simon equations on the melting of solidified gases. M.G.J.

N68-20524 Pennsylvania State Univ., University Park.

THE STATISTICAL MECHANICS OF SIMPLE LINEAR MOLECULES

John Robert Sweet (Ph.D. Thesis) 1966 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-5976

The principles of a general statistical mechanical theory applicable to molecules of arbitrary shape in fluids of arbitrary density are applied to low density fluids made up of linear or quasi-linear molecules. The potential energy functions and pair correlation functions for three model potentials were written as series expansions in spherical harmonics and the coefficients of the first few terms were evaluated. Higher order terms were found to be of decreasing magnitude in all cases. Two of the model potentials are applicable to nonpolar molecules: A Diatomic potential consisting of two Lennard–Jones (12-6) interaction centers separated by a distance R, and a Kihara potential with a core consisting of a thin rod of length R. The third model potential is a modified Stockmayer potential made up of a Diatomic potential plus a term describing the interaction of two point dipoles parallel to the molecular axes. Dissert. Abstr.

N68-20528# International Centre for Theoretical Physics, Trieste (Italy).

RECENT DEVELOPMENTS IN THEORETICAL NUCLEAR PHYSICS

A. De-Shalit Dec. 1966 20 p refs Presented at the 52d Meeting of the Italian Phys. Soc., Trieste, Italy, Oct. 1966
(IC-66/110) CFSTI: HC $3.00/MF $0.65

The question of the dynamical behavior of nuclei is discussed. It is shown that there is no fundamental theory from which a nucleon–nucleon interaction could be conveniently deduced. Some of the basic hypothesis might have to be checked. ESRO

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N68-19521# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
HIGH TEMPERATURE FURNACE FOR PRODUCTION OF ALKALI PLASMA IN THERMODYNAMIC EQUILIBRIUM [FORNACI AD ALTA TEMPERATURA PER LA FORMAZIONE DI PLASMI ALCALINI IN EQUILIBRIO TERMODINAMICO]
F. Garosi and A. Neri 1967 30 p refs In ITALIAN
(RT/FI-(67)9)

To evaluate the screening efficiency of the described furnaces the derivation of the radiative balance of heat sources is outlined. Two different systems are described for heating to high temperatures (1500 to 2500°K) a furnace designed for the production of alkali plasmas by thermal ionization on incandescent containers and in thermodynamic equilibrium. Author (NSA)

N68-19555# Princeton Univ., N. J. Plasma Physics Lab.
IONOSPHERE THOMSON SCATTER AS A MEANS TO STUDY PLASMA WAVES PROPAGATING ALMOST PERPENDICULAR TO A MAGNETIC FIELD
F. W. Perkins Aug. 1967 25 p refs
(Contract AT(30-1)-1238)
(MATT-555) CFSTI: HC $3.00/MF $0.65

The possibility of studying electrostatic waves in a warm plasma by radar Thomson scatter from the ionosphere is discussed. The first experiment involves studying the multiple roots of the plasma wave dispersion relation in the region $\omega_p^2 = 4\pi ne^2/m > \omega_c^2 = (eB/mc)^2$ with the 1300 Mc/sec radars ($\lambda = 23$ cm) located at the Stanford Research Institute and at Lincoln Laboratory. For these radars the parameter $b = q^2KT/m\omega_c^2$ is close to unity and the presence of multiple roots is important. (Here $T \approx 10^3$°K is the ambient electron temperature and $q = 4\pi/\lambda$ is the wave vector associated with backscatter geometry when the radar wavelength is λ.) The experiment would be to observe scattering at two different frequency shifts from the same region of the ionosphere. The second experiment is the observation of scattered power with frequency shifts in the neighborhood of the lower hybrid resonance at the Jicamarca Radar Observatory. This component of the Thomson scatter spectrum has not yet been observed, and would be a means to monitor the presence of photoelectrons in the magnetosphere above the magnetic equator. The frequency of the lower hybrid resonance is strongly affected by small concentrations of lighter ions and would provide data regarding the ionic composition in the ionosphere and magnetosphere. NSA

N68-19561# Columbia Univ., New York. Plasma Lab.
INDUCED FLUCTUATION AND RADIATION IN A MAGNETOPLASMA
AkinRemi Oho Feb. 1968 129 p refs
(Grants NSF GK-125; NSF GK-1391X)
(Rept.-35)

The investigation of induced fluctuation and radiation in an infinite magnetoplasma is carried out in three parts. First, given, a priori, the electric fields of the fluctuation, a mechanism for the conversion of electrostatic to electromagnetic energy is postulated. Under the assumption that there is a group of favored charges to interact with the fluctuation fields, the transverse energy of the group as a function of time is related to the energy of the fluctuation. A Boosting Factor is derived which accounts for the excess radiation from the charges above the classically expected intensities. In the second part of the investigation, the fluctuation induced by a realistic collection of electrons considered as a persistent process (beam) in a magnetoplasma is examined in the linear regime with the object of obtaining the amplitude, rather than only the dispersion relation, of the fluctuation. The final part of the investigation consists of an experiment on a Q machine cesium plasma. For the first time a 0.2 eV fully ionized quiescent plasma is induced to radiate about the second electron cyclotron harmonic frequency by the injection of an electron beam, which by itself is incapable of producing the observed radiation. Author

N68-19673# Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.
ALFVEN WAVES IN RELATIVISTIC PLASMAS
F. C. Hoh Feb. 1968 16 p refs
(D1-82-0709)

Expressions for Alfvén waves, its Landau damping, and magnetosonic waves are derived in a homogeneous relativistic Vlasov plasma. Relativistic effects reduce the speed of both waves. Author

N68-19706*# Stanford Univ., Calif. Inst. for Plasma Research.
THE ELECTRICAL CONDUCTIVITY OF A COLLISIONLESS MAGNETOPLASMA IN A WEAKLY TURBULENT MAGNETIC FIELD
C. E. Newman and P. A. Sturrock Mar. 1968 20 p refs
(Grant NsG-703)
(NASA-CR-93719; SU-IPR-227) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The behavior of test particles in the presence of uniform, parallel, and steady electric and magnetic fields in addition to a weakly turbulent magnetic field is studied. The quasi-linear approach is used to find a diffusion equation for the distribution function describing the test particles; the diffusion equation describes the pitch-angle scattering experienced by the test particles due to the random fluctuations of the magnetic field. In the weak-electric-field limit the equation is analyzed in detail and an expression for the electrical conductivity in terms of the correlation tensor of the fluctuating field is found. Finally, for the case of a particular model of the turbulence and a Maxwellian distribution of test particles, an explicit formula for the conductivity is given. Author

N68-19735 California Univ., Berkeley.
STATISTICAL THEORY OF CHARGED PARTICLE TRANSPORT IN DISORDERED MAGNETIC FIELDS
Edmond Charles Roelof (Ph.D. Thesis) 1966 225 p
Available from Univ. Microfilms: HC $10.15/MF $3.00 Order No. 67-8639

We study the motion of a charged particle in a time-independent, spatially disordered magnetic field where particle and field parameters are such that the particle undergoes a "magnetic Brownian motion." This motion, where the variations in displacement are due to the cumulative effects of small Markovian random velocity fluctuations, leads to a true spatial diffusion process which becomes anisotropic when the mean part of the magnetic field significantly exceeds the root-mean-square random part. The critical parameter is the "relaxation time" (T) in which the velocity distribution, derived from the solution to a Fokker–Planck equation, relaxes to an asymptotic form independent of the initial distribution. The relaxation time is inversely proportional to the spatial power spectrum evaluated at the wavenumber equal to the inverse of the particle's relativistic gyro-radius in the mean field. Dissert. Abstr.

N68-19767# Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.
HYDROMAGNETIC SURFACE WAVES IN A CONDUCTING LIQUID SURROUNDED BY A FLOWING GAS
Richard Gerwin Jan. 1968 52 p refs
(D1-82-0699)

The stability of the interface between a highly conducting liquid and a flowing, non-conducting gas is studied, supposing a

magnetic field to be parallel to the interface. Arbitrary angles are allowed between magnetic field, flow direction and wave-vector. Author

N68-19807 Oklahoma State Univ., Stillwater.
THE DISTRIBUTION OF CURRENT ON AN INFINITE ANTENNA IN AN ANISOTROPIC INCOMPRESSIBLE PLASMA
Gary Lee Johnson (Ph.D. Thesis) 1966 124 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7240

The method of solution uses Maxwell's equations in conjunction with the boundary conditions on the antenna and the boundary condition at infinity to obtain an integral solution for the longitudinal electric field. The remainder of the field components as well as the current distribution is then found from this longitudinal electric field. A boundary condition at infinity which is more general than the Sommerfeld radiation condition is proposed based on the total energy contained in electromagnetic fields instead of the direction of phase travel or energy flow. The fourth-order wave equation of the medium is found to require two ordinary eigenfunctions and two generalized eigenfunctions for its solution. An exact solution to this wave equation and all the boundary conditions is written in the form of an integral with an infinite range of integration. The integral is evaluated asymptotically for the region close to the antenna but far from the source by applying the Cauchy integral theorem. It is found that the current distribution contains the wave numbers of the two possible plane waves in this medium. Dissert. Abstr.

N68-19808 Oklahoma State Univ., Stillwater.
THE ABSORPTION OF RADIATION IN THE VISIBLE SPECTRUM BY AN ARGON PLASMA
Jarrett Charles Hester (Ph.D. Thesis) 1966 152 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-7233

The absorption characteristics of an argon plasma were established at thirty wavelength values between 4000 and 6000 Å. These findings were then applied to the problem of self-absorption in the plasma, and a criteria for the selection of spectral lines to be used in the spectrographic determination of the plasma temperature was presented. The average absorption coefficients for radiation at thirty different wavelengths were obtained at various power levels and mass flow rates and were then applied to the problem of self-absorption. Self-absorption effects could be neglected for the 0.50 inch diameter plasma column, but significant self-absorption effects may occur in the larger diameter plasma columns. A criteria for selecting spectral lines to be used in spectrographic determination of plasma temperatures was proposed. Various spectral lines experience greater degrees of self-absorption than others and should not be used when the diameter of the plasma column exceeds approximately one inch. The accuracy of the temperatures obtained by the relative intensity method increased significantly if wavelengths were considered for which large differences in upper energy levels existed. For emission from excited particles only, it was found that wavelengths which differed by 1000 Å or more produced best results. Dissert. Abstr.

N68-19851 Cornell Univ., Ithaca, N. Y.
EXCITATION OF CYCLOTRON HARMONIC NOISE IN A BEAM GENERATED PLASMA
Michael Roberts (Ph.D. Thesis) 1966 242 p
Available from Univ. Microfilms: HC $11.05/MF $3.15 Order No. 67-1404

Deliberate, controlled excitation of a special class of electrostatic waves was achieved in a pulsed electron-beam-generated hydrogen plasma. Microwave drive signals near the electron gyro frequency were applied to the electron beam in the form of transverse electric fields. With a change in the magnetic field, the beam plasma system could be made stable or unstable with respect to the emission of narrow-band, cyclotron-harmonic radiation. Whether the system was in the stable or unstable mode, noise could only be measured when the density was sufficiently high that the receiving frequency was less then the upper hybrid frequency. These stimulated noise emissions are closely related to the high-harmonic, nonthermal radiation at microwave frequencies reported in recent years. Dissert. Abstr.

N68-19862# Giannini Scientific Corp., Santa Ana, Calif.
LOSSES IN PLASMA ACCELERATION
Adriano C. Ducati Nov. 1967 89 p refs
(Contract AF 49(638)-1743)
(AFOSR-68-0004; TR-117-1743; AD-665142)

A study of the vacuum tank environment of an MPD arc jet was initiated by means of static and impact pressure measurements and by measurement of heat flux to calorimeter slugs distributed within the tank, in order to obtain an understanding of conditions which lead to environmental interference. The measurement of heat flux to calorimeter slugs placed at different axial positions near the tank walls shows that the distribution of the radial heat flow from the exhaust jet reaches a maximum about ten inches from the anode face and is nearly independent of power and magnetic field strength. TAB

N68-19893# Innsbruck Univ. (Austria). Inst. for Theoretical Physics.
INVESTIGATION OF PLASMA INSTABILITIES AND ADDITIONAL MHD INVESTIGATIONS Summary Report No. 1, 1 Jan.–31 Dec. 1967
Ferdinand Cap, Franz Herrnegger, Peter Unteregger, Gottfried Tinhofer, Helmut Faiser et al 31 Dec. 1967 103 p refs
(Contract F61052-67-C-0014)
(AFOSR-68-0236; AD-664924)

The main purpose of the research is to develop mathematical methods for the treatment of nonlinear plasma stability problems for finite and infinite electric conductivity and to apply them to problems concerning the energy balance in magnetogasdynamic generators and in a magnetic nozzle. Concerning the magnetic nozzle we have investigated the magnetic boundary layer which is characterized by negligible ordinary viscosity and weak but dominant magnetic viscosity. The coaxial Hall current accelerator has been investigated taking into account ion slip and variable electric conductivity. The stability of an incompressible nondissipative plasma flow with unstable density gradient has been investigated by the help of Laplace transformation. A procedure based on the normal mode analysis has been used to investigate the influence of electric resistivity on the stability behaviour. Furthermore the problem of plasma-wave reflection has been investigated using the Vlasov-Poisson equation. Author (TAB)

N68-19942# Aerospace Corp., El Segundo, Calif. Plasma Research Lab.
WAVE PROPAGATION IN A WAVEGUIDE PARTIALLY FILLED WITH PLASMA IN AN INFINITE AXIAL MAGNETIC FIELD
Vladislav Bevc Oct. 1967 54 p refs Submitted for publication
(Contract F04695-67-C-0158)
(TR-0158(9220-02)-2; SAMSO-TR-68-33; AD-664876)

Electromagnetic wave propagation for axisymmetric and dipolar modes in a circularly cylindrical waveguide containing a plasma column in an infinite axial magnetic field is studied. The plasma column is assumed to be cold, collisionless, and of uniform density, with a diameter one-half the diameter of the waveguide. Numerical solutions of the dispersion equation for typical cases at various values of the plasma density are presented. The electric field and power flow density distribution are examined quantitatively for representative modes with reference to the existence of surface waves. It is shown that for an infinite magnetic field the high frequency field distribution within the plasma can be a modified

Bessel function of the first kind only for the superluminous phase velocities and only at plasma frequencies that exceed the lowest vacuum waveguide cutoff frequency. For slow waves of very short wavelength, omega/c<<2 pi/lambda sub g, the electromagnetic field and the power flow density distribution are found to be confined to the plasma column with practically no field existing in the vacuum between the plasma and the waveguide wall. Author (TAB)

N68-19962*# Michigan Univ., Ann Arbor. Electron Physics Lab.
FREQUENCY MULTIPLICATION IN HIGH-ENERGY ELECTRON BEAMS Semiannual Progress Report, 1 Apr.–1 Oct. 1967
W. D. Getty, R. J. Lomax, and J. E. Rowe Feb. 1968 17 p refs
(Grant NGR-23-005-183)
(NASA-CR-93743; SAPR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Summaries are presented for high energy studies dealing with a relativistic electron beam device, beam-plasma interactions, and the time-dependent nonlinear analysis of electron beam-plasma interaction. Nonlinear Lagrangian analysis of beam-plasma systems is also reported, as is the harmonic current generation in a beam-plasma system. Studies of cyclotron harmonic instabilities deal with approximate dispersion equation, electron beam parameters, and experimental results. M.W.R.

N68-20176*# Stanford Univ., Calif. Inst. for Plasma Research.
CYCLOTRON HARMONIC WAVE PROPAGATION AND INSTABILITIES
J. A. Tataronis Dec. 1967 199 p refs
(Grant NGR-05-020-077; Contract AT(04-3)-326)
(NASA-CR-93818; SU-IPR-205) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A theoretical study is presented of the electrostatic space-charge waves which propagate in a hot plasma immersed in a constant and uniform magnetic field. It is based on the self-consistent solution of the collisionless Boltzmann equation with Poisson's equation in infinite planar geometry and is restricted to interactions which involve only electrons. By considering a series of velocity distributions, a clear and comprehensive picture of the propagation characteristics and stability properties of these waves has been obtained. Author

N68-20189# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
THE EFFECT OF FINITE BEAM WIDTH FOR A RUTHERFORD COLLISION CROSS SECTION
E. L. Battle, A. L. Marvin, Jr., and J. J. Osstifin 30 Jan. 1968 10 p refs
(AFIT-TR-68-2; AD-664874)

The effect of finite beam width on the observed collision cross section was calculated numerically on the IBM 1620 computer using a Coulomb interaction potential. TAB

N68-20273# Northwestern Univ., Evanston, Ill. Dept. of Astronomy.
NON-LINEAR CORRECTIONS TO SPECTROSCOPIC TEMPERATURE MEASUREMENTS IN TURBULENT ARC PLASMAS Final Summary Report, Jan. 1966–Apr. 1967
Jay Burns Wright-Patterson AFB, Ohio AF Mater. Lab., Dec. 1967 74 p refs
(Contract AF 33(615)-3355)
(AFML-TR-67-371; AD-665143)

A detailed study was made of the statistical properties of short time local temperature fluctuations in a turbulent arc plasma jet with temperatures ranging from 4000-7000K. The results of the study are given in the form of autocorrelation functions of temperature fluctuations at various locations in the plasma jet. Instantaneous temperatures were measured spectroscopically using violet CN band spectra and fluctuations could be determined on time scales as short as 1-2 microseconds. One objective of the study was to develop a relatively simple means of correcting the apparent temperature as measured by a slow integrating detector such as the photographic plate used in conventional spectroscopy to obtain the true average temperature obtained from time-resolved spectroscopic methods. A tentative method is proposed for evaluating the difference between apparent and true average temperatures in a turbulent plasma by an empirical relation between brightness fluctuations and temperature fluctuations that allows the latter to be inferred from measurements of the former which can be carried out with very simple equipment. Author (TAB)

N68-20287*# Pennsylvania State Univ., University Park. Ionosphere Research Lab.
MODEL STUDIES OF LOW ENERGY PLASMA IN THE OUTER MAGNETOSPHERE
J. M. Grebowsky 15 Mar. 1968 151 p refs
(Grants NsG-134-61; NSF GP-5611)
(NASA-CR-93819; SR-317) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The motion of low energy plasma in the outer magnetosphere is considered. In particular, theoretical plasma models are set up to describe the motion of plasma along a magnetic field line, as the plasma and the "frozen-in" field follow the convection pattern inherent to the "open" model of the magnetosphere. The component of the electric field parallel to the earth's magnetic field lines plays a significant role in this investigation. Using model distribution functions the electron density is determined at every point along the open field lines as a function of the local electrostatic potential. Given the proton density at all points along an open field line, the derived density–potential profiles are used to determine the parallel electric field variation along the field line. Author

N68-20289 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
THE INITIAL VALUE PROBLEM FOR A PLASMA IN AN EXTERNAL ELECTRIC FIELD [ZAGADNIENIE POCZATKOWE DLA PLAZMY W ZEWNETRZNYM POLU ELEKTRYCZNYM]
A. Kuszell and A. Senatorski 1967 25 p refs Submitted for publication
(INR-829/21/PP) CFSTI: $3.00

The longitudinal plasma oscillations in an external electric field are investigated by means of numerical solutions and some approximate technique. For weak external fields the phase integral approximation and multitime perturbation technique are used. The approximate solution in the form of damped oscillations with the time dependent frequencies are found. The mechanism of instability growing is discussed. Author

N68-20296*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A COAXIAL-FLOW-STABILIZED ARC
Chester D. Lanzo Washington Apr. 1968 20 p refs
(NASA-TN-D-4517) CFSTI: HC $3.00/MF $0.65 CSCL 20I

This report describes and evaluates a new experimental coaxial-flow-stabilized ac arc facility and presents the results of a study of the general characteristics of an ac arc which has been stabilized or held in place by the action of the coaxial flow of two different gases. The arc is maintained in a central jet of axially flowing argon, between an upstream and a downstream electrode. An outer stream of gas flows coaxially around the center argon jet. Both nitrogen and helium were used in the outer stream. Tests were conducted to determine qualitatively the effect of varying the relative velocities of the inner and outer gas streams. These tests were conducted at a chamber pressure of 8 to 25 psia (55×10^3 to 172×10^3 N/m^{2}abs) and arc lengths of 1 to 12 inches (2.54 to 30.5 cm). Frequency was varied from 12 to 22 cps (12 to 22

Hz). Current levels of 500 to 1000 amperes were run. Visual observations were made, and voltage and current measurements were recorded. In addition, individual frames from a high-speed motion-picture film were examined. These data indicate that the coaxial, two-gas flow pattern causes stable arc operation and that the arc behavior is relatively insensitive to changes in the velocity of either gas stream. Author

N68-20297 Princeton Univ., N. J.
STRUCTURE OF THE CURRENT SHEET IN A PINCH DISCHARGE
Rodney Lane Burton (Ph.D. Thesis) 1966 145 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-5706

The structure of a propagating current sheet in a cylindrical pinch discharge in argon is studied experimentally and analytically. The azimuthal magnetic field, $\bar{B}_\theta$, is mapped throughout the discharge, yielding patterns of current density, $\bar{j}$. From a inventory of the $\bar{j}\times\bar{B}$ distributions, it is deduced that the bulk of the gas is accelerated to the current sheet velocity. The patterns of radial electric field, E_r, normal to the current sheet, are mapped with a coaxial floating double probe. Based on a one-dimensional, constant compression model, the E_r field appears to be of sufficient magnitude to allow conduction of all axial current by electrons in collisionless $\bar{E}_r\times\bar{B}_\theta$ drift. This field is not strong enough, however, to accelerate ambient ions to the sheet velocity, suggesting that gasdynamic forces also participate in the interaction. This model also identifies ohmic heating in the sheet with the product of radial ion current density and E_r. Comparative measurements in neon, argon, and krypton, keeping the ambient mass density constant, indicate that this ohmic heating decreases with increasing molecular weight. Dissert. Abstr.

N68-20302# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati.
EQUATION OF STATE OF A DENSE MULTIPLY IONIZED PLASMA
J. G. Linhart Jul. 1967 18 p refs Sponsored in part by EURATOM
(LGI-67/14) CFSTI: HC $3.00/MF $0.65

The equation of state of a dense multiply ionized plasma, required for calculating in plasma liners, is approached both through a constant density model and through a Thomas–Fermi model and values for the effective adiabatic coefficient are given. The structure of multiply ionized atoms in thermal equilibrium should correspond to a model in-between. ESRO

N68-20418# Comitato Nazionale, per l'Energia Nucleare, Frascati (Italy). Laboratori Gas Ionizzati.
INSTABILITY OF A NEUTRAL SHEET
M. Dobrowolny Sep. 1967 34 p refs Sponsored in part by EURATOM
(LGI-67-17) CFSTI: HC $3.00/MF $0.65

The stability of a neutral sheet configuration with respect to mirror-like perturbations is analyzed in the linear regime. An analytical expression for the linear growth rate of the low frequency electromagnetic modes is derived using a simplified model for the particle orbits. Considerations on the actual mechanism of the instability are also given. Author (ESRO)

N68-20445 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Physics.
FOCUSING PROPERTIES OF SOME STATIC NONUNIFORM ELECTRIC AND MAGNETIC FIELDS
S. Kulinski 1967 24 p refs Submitted for publication
(Rept.-845/7/PL) CFSTI: $3.00

The motion of a charged particle in the superposition of the electric field of a cylindrical capacitor with the axial homogeneous magnetic field and the magnetic field of line current flowing along the axis of the capacitor, is considered. The equations of trajectories are written in the form of integrals, which are then evaluated approximately, under the assumption of small Larmor radius. Application of the results of coaxial plasma accelerators and rotating plasma devices is briefly considered. The focusing properties of these fields are analysed in some detail. Particularly it is shown that the second order focusing can be accomplished providing that the field intensities are properly chosen. Author

N68-20480# Comitato Nazionale per l'Energia Nucleare, Frascati, (Italy). Lab. Gas Ionizzati.
MICRO-FIELD FLUCTUATIONS IN STABLE NON-EQUILIBRIUM PLASMAS
M. Bornatici and F. Engelmann Oct. 1967 23 p refs Sponsored in part by EURATOM
(LGI-67/18) CFSTI: HC $3.00/MF $0.65

The spectrum of field fluctuations of arbitrary polarization in a homogeneous and stationary stable plasma in the absence of external fields is calculated in a simple way. In particular, and case treatment of longitudinal and transverse fluctuations, is investigated. As a special case, plasmas in thermal equilibrium are also considered. Author (ESRO)

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N68-19522# Institut za Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).
HIGH ENERGY SPUTTERING OF Zn SINGLE CRYSTALS
B. D. Perovic May 1966 8 p refs
(IBK-435)

An investigation was made in which Zn single crystals were bombarded by Ar^+ ions in the energy range of 1 to 50 keV. The ion current density on the target was between 10 and 30 μ amp/cm^2. The ion beam was exposed to the different crystallographic planes of the hcp lattice of Zn specimens, the basal plane as well as the side planes of the hexagonal prism. The results are presented. NSA

N68-19678# Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf.
THE MEASUREMENT OF PRESSURE-INDUCED PHONON FREQUENCY SHIFTS IN SODIUM IODIDE [ZUR MESSUNG DER DRUCKABHAENGIGKEIT VON PHONONENFREQUENZEN IN NATRIUMJODID]
G. Quittner and S. Vukovich (Wien Univ.) 1967 12 p refs In GERMAN; ENGLISH summary Presented at the Ann. Austrian Physicists Soc. Conv., Innsbruck, 1967
(Contract AF 61(052)-638)
(SGAE-PH-57/1967)

The measurement of pressure-induced phonon frequency shifts presents some particular problems when applied to NaI. Among these, there is the two-atomicity of the primitive cell and the presence of incoherent scattering. In practice, the measurement is considerably more difficult in flat parts than in steep parts of the dispersion curves, and also more difficult in outer than in inner regions of the Brillouin zone. Because of the smallness of the effect, it is necessary to measure each phonon in several points to account for possible systematic errors. A few examples of measured frequency shifts are shown. Author

N68-19688 Oklahoma State Univ., Stillwater.
HIGH TEMPERATURE CONDUCTIVITY OF GROWN STANNIC OXIDE SINGLE CRYSTALS
Howard Franklin Kunkle, Jr. (Ph.D. Thesis) 1966 123 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7245

A method of growing stannic oxide single crystals has been developed. Electrical properties of specimens grown from a cuprous oxide flux have been investigated using electrical conductivity and thermoelectric power techniques. A description of the conduction mechanism has been provided in terms of a simple broad-band semiconductor model extended to include the effects of bulk compensation and a surface space charge layer associated with the presence of chemisorbed oxygen. Electrical conductivity results show two distinct regions of behavior. At temperatures above about 560°C, consistent slopes are obtained for plots of log conductivity vs reciprocal temperature. Below 560°C, the slopes are strongly dependent on the past history of heat and pressure treatment. The high temperature data are taken to be indicative of intrinsic behavior and lead to an absolute zero forbidden gap width of 2.7 eV as compared to a direct transition optical gap width of ≈4.0 eV. Dissert. Abstr.

N68-19695 Pennsylvania Univ., Philadelphia.
LOCALIZED IMPURITY STATES IN METALS: 1: RESISTIVITY AND SPECIFIC HEAT OF DILUTE ALLOYS OF NICKEL IN BERYLLIUM 2: NUCLEAR MAGNETIC RESONANCE OF DILUTE ALLOYS OF Cu–Mn_xAl_y
Alan Petlin Klein (Ph.D. Thesis) 1966 122 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7849

In part one, the results of an experimental study of the resistivity and specific heat of dilute solid solutions of nickel in beryllium are presented. The addition of small amounts of nickel to the beryllium host metal gives rise to large changes in both quantities. In part two, an experimental study of the RKKY conduction electron spin polarization in the vicinity of a Mn localized magnetic moment in CuMn alloys containing small concentrations of Al as non-magnetic scattering centers is presented. The low temperature Cu^{63} nuclear magnetic resonance linewidth is used as a probe. The effect of the aluminum impurities is to reduce the temperature dependent linewidth and the associated spin-density oscillations by limiting the conduction electron mean free path. Dissert. Abstr.

N68-19776# Sperry Rand Research Center, Sudbury, Mass.
FLUORESCENT ION INTERACTION IN LASER CRYSTALS Final Report, 1 Dec. 1966–30 Nov. 1967
William W. Holloway Feb. 1968 41 p refs
(Contract N00014-67-C-0266; ARPA Order 306; Proj. Defender)
(SRRC-CR-67-67; AD-665033)

Factors influencing the fluorescence of the neodymium ion in garnet crystals (especially Y3Al5O12) were investigated in order to improve the laser characteristics of these materials. In order to increase the doping levels of the active ions the effect of compensating ions on the concentration of neodymium ions for given growth conditions were investigated. Possible deleterious effects in the optical properties of the active ion in the presence of these compensating ions were also studied. The major degradation of the laser characteristics is the result of the coring of the Y3Al5O12:Nd crystals. The use of energy transfer to enhance the fluorescence of the neodymium ion was considered. Energy transfer from the cerium ion and from the chromium ion to the neodymium ion was observed. In collateral studies, the optical properties of the cerium ion and the chromium ion in garnet crystals were extensively investigated. Methods of improving the efficiency of the energy transfer in these materials were considered. Author (TAB)

N68-19778 Oklahoma State Univ., Stillwater.
EFFECTS OF LIGHT ON THE ELECTRON SPIN RESONANCE OF DIAMOND
John Paul King (Ph.D. Thesis) 1966 118 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-7242

An investigation of the effects of monochromatic light on the electron spin resonance of diamond was conducted in order to obtain further information on the electron states having associated energy levels in the band gap of diamond and to identify the defect centers responsible for the states. The study includes a review of optical and related properties of diamond and a review of the fundamental concepts of magnetic resonance. The experimental investigation required modification of the basic ESR spectrometer and construction of an efficient optical illumination system. A dewar system was constructed for observation of optical effects on ESR at low temperature. Dissert. Abstr.

N68-19782 Clemson Coll., S. C.
THE EFFECT OF HIGH ELASTIC UNIAXIAL STRAIN ON THE RESISTIVITY AND THE SUPERCONDUCTING TRANSITION TEMPERATURE OF TIN WHISKERS
Jack Hayne Davis (Ph.D. Thesis) 1966 73 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-6953

Since bulk single crystal tin is soft and ductile only the effects of small elastic uniaxial stress (σ) on the resistivity and superconducting transition temperature (T_c) have been measured. These results produced only a first order coefficient; i.e., the slope of the curve at zero stress. By using high strength single crystal tin whiskers the maximum elastic stress was increased by two orders of magnitude. The effect of strain in the ⟨100⟩ direction on both resistivity and T_c was found to be highly nonlinear with less nonlinearity on the ⟨101⟩ direction and practically none in the ⟨001⟩ direction. These data in the low strain limit agree with previous first order stress data obtained by Grenier for critical field (H_c) and by Allen for resistivity. Six observations are made which tend to indicate that Fermi surface distortion is responsible for the nonlinearities observed in the ⟨100⟩ direction. Dissert. Abstr.

N68-19792*# Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering.
A STUDY OF DEFECT STRUCTURES WITH THE FIELD ION MICROSCOPE Semiannual Report, 1 Sep. 1967–29 Feb. 1968
J. J. Hren, R. W. Newman, R. C. Sanwald, and U. T. Son 29 Feb. 1968 177 p refs
(Grant NGR-10-005-039)
(NASA-CR-93720; SAR-4) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Results of a survey study of the secondary defects existing in quenched platinum are presented. Transmission electron microscopy used in conjunction with field ion microscopy has yielded direct experimental evidence for the existence of prismatic dislocation loops as well as polyhedral voids. For the most part, the dislocation loops were observed as black spot defects in the electron microscope and were resolvable only via field ion microscopy. The void concentration reached a maximum of $7 \times 10^{14}/cm^3$ after annealing at 400°C for 24 hours and fell sharply on either side of this temperature. The shape of the voids was found to be a function of the concentration. Small tetrahedral voids have been discovered in field ion specimens, and it is postulated that these clusters are the nuclei for both voids and dislocation loops, depending upon the number and efficiency of the vacancy sinks in the local environment. Author

N68-19850 Cornell Univ., Ithaca, N. Y.
F-CENTER FORMATION BY FUNDAMENTAL ABSORPTION IN KI

Fred Tobias Goldstein (Ph.D. Thesis) 1966 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-1510

The formation of F-centers (and associated centers) in KI by irradiation with ultraviolet light was investigated. Optical absorption measurements were employed to indicate the number of F-centers formed. A study was made of the variation, as a function of F-center concentration, of the well-known low temperature intrinsic KI luminescence excited by illumination in the fundamental band. The F-centers, and V-centers in proportion, were produced by irradiation with the unfiltered mercury lamp at 195°K. It was found that the presence of these centers quenches the luminescence (measured at 77°K). Further studies indicated that it is not the F-center itself that causes the quenching, and led to the possibility that the V-center or possibly a V–F complex is responsible for the quenching phenomenon. Dissert. Abstr.

N68-19881 Washington Univ., Seattle.
ION DOPED PEROVSKITE CERAMICS
Fennimore Nelson Bradley (Ph.D. Thesis) 1966 292 p
Available from Univ. Microfilms: HC $13.30/MF $3.75 Order No. 67-7628

The effects of cation additions upon the electrical properties of ferroelectric perovskite ceramics were studied and correlated to microstructural characteristics as indicated by X-ray diffraction analyses. Results indicated that pronounced variations in the electrical properties of pure and doped barium titanate ceramics are primarily due to the fired grain size of the material. Additives produce strong effects because of inhibition or acceleration of grain growth. Doping also influences densification and electrical losses. Some solid solutions occur which cause shifts in the Curie temperature as the tegragonality ratio is changed. Certain additives cause extensive second phased formation, particularly Nb, Ta, Sb, Mo and W. Transition metal oxide additions to barium titanate produce metastable phases at 1300°C and the hexagonal phase at 1400°C. Dissert. Abstr.

N68-19884# Massachusetts Univ., Amherst. Polymer Research Inst.
OPTICAL CHARACTERIZATION OF THE ORIENTATION OF AMORPHOUS POLYMERS AND AMORPHOUS PARTS OF CRYSTALLINE POLYMERS
R. S. Stein and B. E. Read Sep. 1967 39 p refs Supported in part by NSF and Am. Chem. Soc.
(Contract Nonr-3357(01))
(ONR-TR-94; AD-664963)

Techniques for characterizing the orientation of amorphous polymers include birefringence, infrared, visible and ultraviolet dichroism, and polarization of fluorescence. The infrared dichroism technique does not have the precision of birefringence measurements but may offer more detailed information about the molecular orientation. Particular absorption bands characterize the orientation of transition moment directions of partical parts of the molecule. Ultraviolet and visible dichroism serve to characterize the orientation of molecules having suitable chromophoric groups. There is considerable uncertainty in this assumption, however. The polarization of fluorescent light arising from chromophoric groups on the molecule or on added dyes provides additional information about the orientation distribution in that it depends upon the mean fourth power of the cosine of the orientation angle, while the birefringence and dichroism depend upon the mean square of this angle. The orientation of the amorphous regions of crystalline polymers may be obtained from subtracting crystalline contributions to birefringence or to absorption bands by using absorption bands associated with amorphous regions or by studying the absorption or fluorescence by dyes which are absorbed by amorphous regions. Author (TAB)

N68-19891# Harry Diamond Labs., Washington, D. C.
COMPARISON OF THE GROUND TERM ENERGY LEVELS AND CRYSTAL FIELD PARAMETERS OF TERBIUM IN SCHEELITE CRYSTALS
R. R. Stephens and D. E. Wortman Nov. 1967 24 p refs
(HDL-TR-1367; AD-664769)

A study was made of the infrared absorption spectra of triply ionized terbium in single crystals of CaWO4, SrWO4, CaMoO4, and SrMoO4. Particular emphasis was placed on determining the crystal field parameters for these host crystals of the scheelite structure. In recording the data, the crystals were held at temperatures near that of liquid helium (4.2K) or of liquid nitrogen (77K). The transitions observed were from the (7)F6 ground multiplet to the (7)F0, (7)F1, (7)F2, and (7)F3 multiplets. Russell-Saunders wave functions were used in the calculations. The spin-orbit and crystal field interactions were considered responsible for the splitting of the energy levels of the (7)F ground term. The S4 symmetry properties of the crystalline field were used to simplify the analysis of the spectra and the IBM7094 computer calculations. The magnitude of the leading terms in the crystal field potential expansion were found to be greater for the Ca lattices than for the Sr lattices. Also the Tb(3+) spectra in the Sr lattices have fewer extra lines, as predicted by the symmetry properties, than in the Ca lattices. The theoretically predicted energy levels for the entire ground term of triply ionized terbium in each scheelite are given as are the experimental energy levels determined from the recorded spectra. Author (TAB)

N68-19924*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF 22 MEV PROTON AND 2.4 MEV ELECTRON RADIATION ON BORON AND ALUMINUM-DOPED SILICON SOLAR CELLS
Gilbert A. Haynes and Walter E. Ellis Washington Apr. 1968 67 p refs
(NASA-TN-D-4407) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A comparative analysis is presented of the effects of proton and electron irradiation on the electrical properties of boron-doped and aluminum-doped, N on P, silicon solar cells having base resistivities of 1 ohm-cm and 10 ohm-cm. Electrical measurements were made before and after irradiation at various flux levels up to 2.1×10^{12} protons per square centimeter at 22 MeV, and 1.0×10^{16} electrons per square centimeter at 2.4 MeV. Measurements of short-circuit current and maximum power under illumination with a tungsten light source and a solar simulator indicate that 1 ohm-cm aluminum-doped cells are slightly more resistant to damage by 2.4 MeV electrons than 1 ohm-cm boron-doped cells; however, 10 ohm-cm boron-doped cells were found to be more resistant to electron damage than 10 ohm-cm aluminum-doped cells. Spectral response measurements made before and after irradiation indicated no significant difference due to the type of doping element employed. From these spectral response curves, conversion factors were computed for use in predicting the output of solar cells in space sunlight from direct measurements under tungsten light or the solar simulator. Author

N68-19955*# Hiram Coll., Ohio. X-Ray Physics Lab.
DEFECT PRODUCTION IN SINGLE CRYSTAL RESULTING FROM ION BOMBARDMENT Semiannual Status Report, 1 Jul.–31 Dec. 1967
Lawrence B. Shaffer 31 Jan. 1968 7 p refs
(Grant NGR-36-019-001)
(NASA-CR-93768; SASR-3) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Summary information is provided on the reassembly of the double crystal X-ray spectrometer, and on the problems encountered in installing the vacuum system. It is also reported that a theoretical evaluation of the ion surface interaction was initiated, along with a study on the interpretation of the X-ray data to be obtained. M.G.J.

N68-19965# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SHALLOW DONOR LEVELS OF InSb IN A MAGNETIC FIELD
David M. Larsen 21 Nov. 1967 21 p refs
(Contract AF 19(628)-5167)
(TN-1967-53; ESD-TR-67-566; AD-664919)

We consider, in the effective mass approximation, the problem of a hydrogenic atom in a strong static magnetic field. The ground state and the lowest lying states of angular momentum plus or minus h are calculated variationally, first for a simple parabolic conduction band and then for the nonparabolic conduction band of InSb. Both the use of improved variational trial functions and the incorporation into the theory of the nonparabolic conduction band are novel features of the present calculation. The results are compared with previous work. Nonparabolic effects are found to be significant for the energy of the lowest lying state of angular momentum +h. The weak-coupling polaron theory is used to derive an upper bound to the shift of the ionization energy of the ground state of the impurity due to electron-LO phonon interaction. Polaron effects on the ground state ionization energy are thereby shown to be negligible in InSb. The bound obtained may, however, prove useful in estimating polaron effects in materials with larger coupling constants. Author (TAB)

N68-20030 Iowa State Univ. of Science and Technology, Ames.
THERMAL EXPANSION OF TETRAHEDRALLY BONDED SOLIDS AT LOW TEMPERATURES
Paul Whitney Sparks (Ph.D. Thesis) 1966 114 p
(Contract W-7405-ENG-82)
(IS-T-114) Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-5628

The linear thermal expansions of Si, Ge, GaAs, GaSb, InAs, and InSb were measured between 2°K and 30°K using a linear variable transformer technique. Sensitivities in length changes of 10 cm long samples of close to 0.02 Å were observed. In general, the data show a region of positive thermal expansion at very low temperatures and this is followed by a region of relatively large negative thermal expansion at higher temperatures. From previous work it is known that at still higher temperatures the thermal expansion again becomes positive. The present data on Ge and Si agree satisfactorily with previous results. Dissert. Abstr.

N68-20031 Iowa State Univ. of Science and Technology, Ames.
RELATIVISTIC ENERGY BANDS AND FERMI SURFACES FOR SOME HEAVY ELEMENTS
Stewart Charles Keeton (Ph.D. Thesis) 1966 123 p
(Contract W-7405-ENG-82)
(IS-T-109) Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-5601

This study presents a theoretical investigation of the relativistic effects on the band structure of heavy metals, i.e., metals composed of heavy elements. The theoretical method used in the calculations presented here was the relativistic augmented-plane-wave method. Relativistic and nonrelativistic energy bands are compared for Lu, Ac and Th. The relativistic effects are particularly striking for Ac and Th. One relativistic effect that is quite apparent from the energy bands presented here is the tighter binding of the atomic electrons with low angular momentum. This has the effect of moving the s-like band in Ac and Th down by about .2 Rydberg at the center of the Brillouin zone. The energy bands and Fermi surfaces of Hg, Th and Dy are also presented. Available experimental de Haas–van Alphen and magnetoresistance data are compared with theoretical predictions calculated for Hg. The agreement is good. Dissert. Abstr.

N68-20039 California Univ., Berkeley.
ANGULAR DISTRIBUTION AND YIELD MEASUREMENTS OF SINGLE CRYSTAL COPPER SPUTTERED BY 1 TO 10 KEV CESIUM IONS
Noble Thomas Olson (Ph.D. Thesis) 1966 89 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-5135

A radioactive tracer technique has been applied to the measurement of the yield and angular distribution of copper sputtered from a monocrystalline target bombarded by a cesium ion beam of 1 to 10 KeV energy. The ion beam was incident normal and at 45° to the target surface which corresponded to the (100) crystallographic plane. The sputtering yield curve at normal incidence is characterized by its low value (6.5 to 5 KeV) and the maximum achieved at 5 KeV with a subsequent decrease at higher energies. By contrast, the yield curve at 45° incidence had substantially higher values and increased monotonically over the entire 1 to 10 KeV range. The low yield at normal incidence is a result of the openness of the (100) crystallographic fact while at 45° incidence the ion penetration depth is decreased causing an increased yield. Dissert. Abstr.

N68-20062# Naval Ordnance Lab., White Oak, Md.
UPPER CRITICAL FIELD OF SUPERCONDUCTING TIN AND LEAD FILMS DISORDERED DUE TO DEPOSITION ON SUBSTRATES HELD AT LOW TEMPERATURES
Richard W. Brown 7 Nov. 1967 198 p refs
(NOLTR-67-168; AD-664824)

Measurements were made of the superconducting upper critical field of films of tin and lead disordered due to deposition on substrates held at liquid helium temperature. The behavior differs accordingly as the film thickness is thin or thick compared to the magnetic penetration depth. Analysis of the two temperature regimes is made within the framework of the Ginsburg-Landau theory. Author (TAB)

N68-20078# Pennsylvania Univ., Philadelphia.
ACOUSTICAL ACTIVITY AND OTHER FIRST ORDER SPATIAL DISPERSION EFFECTS IN CRYSTALS
D. L. Portigal and E. Burstein Dec. 1967 33 p refs Submitted for publication
(Contract Nonr-551(51))
(TR-15; AD-665290)

It is demonstrated phenomenologically that, as a result of first order spatial dispersion, an acoustic activity of transverse acoustic waves, the analog of optical activity, arises in certain crystal classes. Crystals which are optically active are also found to be acoustically active. Furthermore, in the case of propagation along high symmetry axes, the effect manifests itself, as in the case of optical activity, as a simple rotation of the plane of polarization of transverse acoustic waves. Acoustic effects of first order spatial dispersion which have no optical analog are also treated. Acoustical activity can also be inferred from the transformation properties of the acoustic phonons, and the acoustical activity of crystals may, thereby, be derived from phonon dispersion curves. An estimate of the magnitude of the acoustical activity of tellurium is so obtained. The effects of first order spatial dispersion on transverse optical phonons and the optical properties which arise from them are also considered. Practical problems involved in the observation of acoustical activity are discussed. Author (TAB)

N68-20088# Notre Dame Univ., Ind.
RESEARCH ON SINGLE CRYSTAL ELECTRON EMITTERS Final Report, 1 Apr. 1964–31 Aug. 1967
Edward A. Coomes and Alex A. Petrauskas 11 Nov. 1967 88 p refs
(Contract AF 19(628)-4063)
(AFCRL-67-0669; AD-664892)

A compensation is shown to exist between the coverage Richardson constants for recrystallized W and Mo filaments, clean and with Th adsorbed, which may be explained by the existence of micropatches. The total thermionic emission from thorium adsorbed on single crystal W for theta = 0.6 is predominated by

small patches near the <113> and <116> directions. The average desorption energy of Th from single crystal W changed from 165 to 180 kcal/mol for change of theta from 0.6 to 0. While the Sommerfeld model works well for thermionic emission from Mo, systematics are observed for other transition metals.
Author (TAB)

N68-20096 California Univ., Los Angeles.
THE ANHARMONIC INTERACTIONS OF ACOUSTIC AND INFRARED PHONONS AND THE EFFECTS OF THE PHONON ELECTRIC FIELD ON VIBRONIC SPECTRA AND ON THE LATTICE-DIPOLE INTERACTION IN KCl:OH⁻
Lawrence Arthur Vredevoe (Ph.D. Thesis) 1966 153 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-5992

The attenuation of high energy phonons at low temperatures ($\hbar\omega >> kT$) via three and four phonon anharmonic processes is treated theoretically. It is found that the lowest branch of the phonon spectrum has an anomalously long life time, proportional to $\exp(\alpha\hbar\omega/kT)$, where α is a constant of order unity, while the other two branches have much shorter life times. The conservation of momentum and energy for the normal processes forbids processes where phonons from the lowest branch split into two or three phonons—they can only interact in processes where they combine with one or more high energy (i.e., $\hbar\omega >> kT$) thermal phonons. For low temperatures the Bose statistics severely limit the number of high energy thermal phonons with which the lowest branch phonons can interact. Equations are derived to give the relaxation times for the dominant third and fourth order processes for phonons from the (higher) longitudinal and a doubly degenerate transverse branch.
Dissert. Abstr.

N68-20132# Bausch and Lomb, Inc., Rochester, N. Y. Research and Development Div.
INFRARED COATING STUDIES Quarterly Report, 15 Sep.–15 Dec. 1967
R. L. Maier 15 Dec. 1967 17 p refs
(Contract DA-44-009-AMC-1707(E))
(QR-6; AD-664786)

The study is motivated by a need for filtering out various wavelengths bands in the infrared, such as for astronomical purposes. Theoretically, Lorentz dispersion was applied, and using a curve fitting technique described in a previous report, the optical constants of mineral $PbMoO_4$ have been computed dispersively. Thus the reflectance, and transmittance of thin films of $PbMoO_4$ can be computed versus wavelength. In addition, enhancement coatings can be designed. Experimentally, films of $PbMoO_4$ and $CaWO_4$ were prepared on 8 in. diameter glass substrates with varying degrees of success. The best results were obtained using electron bombardment rather than resistance heating. All coatings included in this report were evaporated onto glass substrates at 300C, at a pressure of 0.000012 torr. A condensation rate of one quarter wave of optical thickness/minute was maintained, using a monitor wavelength of 5490A. All films presented were evaporated from a water cooled copper crucible, using electron bombardment.
TAB

N68-20150 Oregon Univ., Eugene.
SOME MICROWAVE AND OPTICAL STUDIES ON POINT DEFECTS IN CaO AND SrO
Douglas Hidetoshi Tanimoto (Ph.D. Thesis) 1966 104 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-6218

Some properties of vacancy and impurity defects were studied in CaO and SrO single crystals using electron paramagnetic resonance and optical absorption techniques. In the course of the study a new vacancy defect was found in CaO with some very interesting properties. This defect, termed the F_1 center, was found to have its electron spins polarized upon irradiation with broad-band unpolarized light at 1.5°K. The optical pumping process involved was analyzed in terms of relaxation rates and selection rules. Relaxation times of both the CaO F and F_1 centers were measured. The transient response of the F_1 system to pulsed light was also observed, and partial success was had in relating this response to details of the optical pumping mechanism. Since certain of the spin resonance transitions are rendered inverted by the process, this system has potential use as an optically pumped maser. The maser threshold condition was, however, not achieved in the present work.
Dissert. Abstr.

N68-20178# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics
WORK HARDENING OF PLASTICALLY NON-HOMOGENEOUS CRYSTALS
M. F. Ashby Jan. 1968 57 p refs
(Contract N00014-67-A-0298-0010)
(TR-549; AD-664831) CFSTI: HC $3.00/MF $0.65

When a non-homogeneous crystal (a crystal which contains hard inclusions of a second phase, for example) deforms plastically, dislocations whose function is to ensure compatible deformation of the parts of the crystal accumulate in it. Unlike dislocations in homogeneous crystals, the density of these compatibility or geometrically necessary dislocations increases in direct proportion to the strain. These extra dislocations lead to extra work hardening in the non-homogeneous crystals. Although this is not the only way in which inclusions, for example, can stimulate work hardening, experiment suggest that it is the most important one.
Author (TAB)

N68-20179# Washington Univ., St. Louis, Mo. Dept. of Physics.
INVESTIGATION OF ELECTRON AND NUCLEAR SPIN-PHONON INTERACTIONS IN METALS AND SEMICONDUCTORS Final Report
Dan I. Bolef Dec. 1967 5 p refs
(Grant AF-AFOSR-841-65)
(AFOSR-68-0262; AD-664913)

Two experiments, both involving the interaction of high frequency phonons with nuclear spins in solids, were initiated under this grant: (i) Research into acoustic interactions with nuclear spins in antiferromagnets, and (ii) Research into acoustic interactions with nuclear spins in metals. The particular relevance of these two studies to the advance of basic knowledge of solids stems from the fact that the sensitive high frequency acoustic techniques utilized in these experiments are capable of investigating directly internal dynamic interactions not easily studied by other techniques. Thus in (i) we have been able to discover and investigate dynamic magnetic interactions (closely related to spin-lattice relaxation effects) in an interesting antiferromagnet, and in (ii) we have been able to begin a thorough study of spin-phonon interactions in bulk metal single crystals.
Author (TAB)

N68-20188# Stanford Univ., Calif. Center for Materials Research.
MATERIALS RESEARCH AT STANFORD UNIVERSITY Annual Report, 1 Jul. 1966–30 Jun. 1967
Dec. 1967 252 p refs Sponsored in part by AEC, NASA, Nat'l. Inst. of Health, and NSF
(Contract ARPA SD-87)
(AR-6; AD-665282)

The report contains brief descriptions of the various individual research programs active during the reporting period, arranged alphabetically by the name of the principal investigator. Also included are lists of publications, doctoral dissertations, faculty and senior staff members, research associates, graduate students and degrees awarded. A name index is included for convenience in locating references to the activities of specific individuals.
TAB

N68-20201# Cornell Univ., Ithaca, N. Y. Materials Science Center.
IMPURITY EFFECTS ON THE IONIZATION STATES OF F-AGGREGATE COLOR CENTERS IN SODIUM FLUORIDE
Ashoka Chandra (Ph.D. Thesis) Jan. 1968 272 p refs
(Contract Nonr-401(54)M-4)
(Rept.-868; TR-8; AD-664943)

The role of hydroxide and peroxide impurities on color-center properties in sodium fluoride were studied with several crystals grown with the Kyropoulous technique. The optical absorption in peroxide doped samples consists primarily of three bands at 275 millimicrons, 235 millimicrons and 195 millimicrons respectively. The production of F centers is determined almost entirely by impurities with a small contribution due to intrinsic processes. The large coloration in hydroxide and peroxide doped samples are explained on the basis of photochemical reactions involving impurities which act as sources of anion vacancies and electrons. Important differences were observed in hydroxide and peroxide doped samples in relation to the charge state of the aggregate centers. Electron-deficient centers are stabilized and the probability of their formation is enhanced in hydroxide doped samples. In peroxide doped samples the excess electron centers are favored. Several new absorption bands were observed in hydroxide and peroxide doped samples. TAB

N68-20216 Illinois Univ., Urbana.
EFFECTIVE MOBILITY IN SILICON SURFACE CHANNELS AS MEASURED WITH THE MOS TRANSISTOR
Robert Francis Pierret (Ph.D. Thesis) 1966 148 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-6697

A detailed study, both theoretical and experimental, was made of the effective mobility in silicon surface channels. Theoretical pursuits included a) specialization of the existing effective mobility theory to silicon and to the MOS transistor, and b) extension of the existing effective mobility theory by the removal of various simplifying assumptions. Mobility measurements were confined primarily to inversion p-channel MOS transistors, although some built-in-channel and inversion n-channel results were obtained. Dissert. Abstr.

N68-20219 Illinois Univ., Urbana.
THE BOGOLIUBOV EQUATIONS AND THEIR APPLICATION TO A NORMAL-SUPERCONDUCTING BOUNDARY
Wesley Northey Mathews, Jr. (Ph.d. Thesis) 1966 209 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-6672

The Bogoliubov equations are used to investigate the pair potential and the electronic excitations associated with a normal-superconducting boundary in an extreme type I superconductor. The method of the Bogoliubov equations has three advantages, for this calculation, over other methods: (1) the method offers a practical means of investigating the properties of a normal-superconducting boundary for *all* temperatures below the transition temperature; (2) much of the physical insight associated with single-particle wave functions can be brought to bear, and (3) the effects of nonlocality in the electrodynamics are taken into account from the outset. The foundation for the calculation is laid by a derivation and discussion of the Bogoliubov equations, in the course of which the equations are extended over the entire range of coupling strengths. Four illustrative examples are considered: (1) the BCS limit; (2) the normal conductor-superconductor contact; (3) an isolated vortex line in a type II superconductor, and (4) a superconductor containing non-magnetic impurities near the transition temperature. Dissert. Abstr.

N68-20230# Delaware Univ., Newark. Physics Dept.
FIELD ENHANCED IONIZATION OF TRAPS
K. W. Boer, G. A. Dussel, and P. Voss Feb. 1968 19 p refs
(Contract Nonr(G)-4336-(00))
(TR-22; AD-665025)

Stationary steplike high-field domains in the range of negative differential conductivity provide the possibility to determine experimentally the carrier density as a function of the electric field. Measurements done with CdS show that the electron density decreases by about 2 orders of magnitude with increasing field between 30 and 70 kV/cm. It can be shown that this is caused by field quenching, i.e., field excitation of minority carriers from hole traps and thereby enhanced recombination. This field excitation of holes, however, cannot be described quantitatively by any classical field excitation mechanism, i.e., by impact ionization or by tunnel effect. These mechanisms would need a considerably higher field than observed for causing the measured effect. Agreement between experiment and theory can be reached by field enhanced ionization of Coulomb-attractive centers. Author (TAB)

N68-20282 Illinois Univ., Urbana.
ANHARMONICITY IN NaCl AND BETA BRASS
Karl Dean Swartz (Ph.D. Thesis) 1966 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-6750

The complete sets of third-order elastic constants of NaCl and beta brass were measured by using a two-crytal interference technique. These constants satisfy fairly well the Cauchy relations, $C_{112} = C_{166}$, and $C_{123} = C_{144} = C_{456}$. This supports the assumption that the interactions are central force type. The more stringent relations, $C_{112} = C_{166}$, $C_{123} = C_{144} = C_{456} = 0$ for NaCl and $C_{112} = C_{123} = C_{456} = C_{144} = C_{166}$ for beta brass, which are imposed on the third-order elastic constants if they are determined mainly by the exchange interaction, are also observed to hold fairly well. The results of the measurement of particular combinations of the third-order elastic constants and the temperature coefficient of the second-order elastic constants which are determined by the two-crystal interference method are compared to values reported in the literature. Dissert. Abstr.

N68-20295*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ELECTRON-BEAM, CRYSTALLIZATION OF SILICON, GERMANIUM, AND CADMIUM SULFIDE
John C. Evans, Jr. Washington Apr. 1968 24 p refs
(NASA-TN-D-4522) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Amorphous semiconductor films were electron-beam irradiated, and the effects were observed in the electron microscope. This study shows that oriented polycrystalline films of silicon, germanium, and cadmium sulfide may be made by electron bombardment of their amorphous films deposited on glass and plastic substrates. This transition was shown to occur without deleterious effects upon the substrates. The film bombardment was conducted both in the electron microscope and in a separate vacuum crystallizer capable of electron-beam raster scanning. Electron micrographs and electron diffraction patterns were used to record the results of the film treatments. Both silicon and germanium films underwent amorphous-to-crystalline changes at substrate temperatures well below the melting points of the semiconductors. Nucleation and crystal growth by coalescence were observed. The compound semiconductor, cadmium sulfide, crystallized by passing through a quasi-liquid state without subliming in the vacuum environment. The thickness of the untreated films was such as to allow transmission electron microscopic studies. Author

N68-20312 Purdue Univ., Lafayette, Ind.
AN ANALYSIS OF THE FREQUENCY DEPENDENCE OF THE CAPACITANCE OF ABRUPT P-N JUNCTION SEMICONDUCTOR DEVICES

William Francis O'Hearn, Jr. (Ph.D. Thesis) 1966 130 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-5477

Frequency dependence of the capacitance of abrupt p–n junction semiconductor devices was analyzed based on small-signal conditions and restricted to devices in which the impurity ratio is several orders of magnitude greater than unity. The total capacitance of the devices is considered to be made up of several components. Each component is analyzed and its frequency dependence determined, and an overall expression for the total capacitance is obtained. To facilitate the study of the individual components of the total capacitance, junction effects and bulk effects are considered separately. The bulk effects arise because of the conduction process in the bulk semiconductor material of the device and are a majority carrier effect. The junction effects are twofold. The first of these is due to charge variations in the transition region of the device and is a field effect. The second is due to the injection of minority carriers into the bulk and is analyzed by consideration of the diffusion process. Dissert. Abstr.

N68-20313 California Univ., Berkeley.
THE MAGNETOTHERMODYNAMIC PROPERTIES OF $CuSO_4$ $5H_2O$ BELOW 4.2°K IN MAGNETIC FIELDS TO 90,000 GAUSS
Roger Joseph Anderson (Ph.D. Thesis) 1966 89 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-4991

The heat capacity and magnetic moment of $CuSO_4 \cdot 5H_2O$ have been measured in the temperature range 0.4 to 4.2°K with magnetic fields of 0 to 90,000 gauss applied parallel to the "a" magnetic axis. These data, together with measurements of the variation of temperature with applied magnetic field along isentropic paths have allowed the determination of the magnetothermodynamic properties of the substance within the ranges of temperature and field stated above. The data are interpreted in terms of the previously postulated picture of two nearly independent magnetic systems, one nearly ideal, and the other antiferromagnetic. Preliminary measurements are described which give the magnetic moment as a function of field along a path of nearly constant low entropy. The existence of two largely independent magnetic systems is again indicated. Dissert. Abstr.

N68-20347*# Southern Methodist Univ., Dallas, Tex. Inst. of Technology.
IMPEDANCE CHARACTERISTICS OF IRRADIATED THIN FILMS Final Report, 1 Jun. 1965–31 Aug. 1967
Roy F. Eberline, David S. Glass, and Lorn L. Howard 1 Dec. 1967 75 p refs
(Grant NGR-44-007-006)
(NASA-CR-93772; PR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The complex electrical impedance characteristics of thin (of the order of 1000 A) bismuth films at infrared frequencies corresponding to the region between 2 and 15 microns are discussed. Equivalent electrical circuits are derived for films having initial resistances in the range between 34 and 350 ohms per square, making use of theory from transmission-line analysis and of measurements of film resistance and infrared transmission. The electron beam irradiation of thin conducting films is considered, and particular problems associated with the determination of irradiation-induced characteristics of thin bismuth films are discussed. The development of instrumentations and techniques for solving these problems is presented. Author

N68-20427# Oak Ridge National Lab., Tenn.
FUNDAMENTAL PROGRAMS, PART 1
In its Metals and Ceram. Div. Ann. Progr. Rept. for period ending Jun. 30, 1967 Nov. 1967 p 3–62 refs (See N68-20426 10-17)

Internal centrifugal zone-growth techniques were developed for growing uranium dioxide crystals. Inhomogeneities in the preferred orientation of polycrystalline niobium were studied in terms of the amount of deformation and position in rolled strip. Analytical methods were developed for transforming X-ray texture data into axial or biaxial pole figures required for the complete representation of fiber and sheet textures. Self-diffusion coefficients were determined for body centered cubic phases of tintanium-vanadium alloys. A fractographic technique was used to study gas bubbles and creep cavities in tungsten. A Coulomb-recoil-implantation method was developed for study of impurities in solids and applied to ^{73}Ge in chromium. Basic research was initiated on uranium nitride. Topological studies of sintering copper powder compacts were used to determine the effect of isostatic pressing on subsequent sintering of partially sintered oxide powder compacts. Physical property data on silicon were tabulated. Spectroscopy of ionic media was carried out. Superconducting materials were studied. The surface reactions of metals were examined, and X-ray diffraction studies of mixed oxide compounds containing beryllia were conducted. E.J.S.

N68-20481*# Field Emission Corp., McMinnville, Oreg.
INVESTIGATIONS OF ELECTRON EMISSION CHARACTERISTICS OF LOW WORK FUNCTION SURFACES Final Report, 28 Sep. 1966–13 Nov. 1967
L. W. Swanson, A. E. Bell, L. C. Crouser, B. E. Evans, and R. W. Strayer Nov. 1967 107 p refs
(Contract NASw-1516)
(NASA-CR-93809) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Phenomena governing production of low work function surfaces and factors affecting the equality and stability of electron emission characteristics were studied. Formation of these low work function surfaces was accomplished by the adsorption of appropriate electropositive adsorbates and the coadsorption of both electropositive and electronegative adsorbates. Adsorption of cesium fluoride on tungsten was studied, as were single plane work function/coverage relationships for cesium and oxygen coadsorbed on tungsten. Studies were made of the adsorption and desorption of mercury on clean and oxygenated tungsten, stability of field emission cathodes, and total energy distribution of field emitted electrons from clean molybdenum. The effect of adsorbed cesium on the total energy distribution of field emitted electrons was also studied. M.W.R.

N68-20501 Indian Inst. of Tech., Kanpur. Dept. of Atomic Energy.
PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM
1967 275 p refs Symp. held in Kanpur, India, 27 Feb.–3 Mar. 1967

CONTENTS:

1. THE THERMAL CONDUCTIVITY OF A POLYCRYSTALLINE ROD OF NICKEL–ZINC FERRITE AT LIQUID HELIUM TEMPERATURES M. S. R. Chari and N. S. Natarajan (Natl. Phys. Lab.) p 1–30 refs (See N68-20502 10-26)

2. BILINEAR ELECTRODYNAMICS OF A SUPERCONDUCTOR S. S. Jha (Tata Inst. of Fundamental Res.) p 31–43 refs (See N68-20503 10-26)

3. CRITICAL FIELDS H_{c2} AND H_{c3} OF THIN FILM TYPE 2: SUPERCONDUCTORS J. S. Rajput and A. K. Gupta (Allahabad Univ.) p 44–47 refs (See N68-20504 10-26)

4. ELECTRON PARAMAGNETIC RESONANCE IN SINGLE CRYSTALS AND PHASE TRANSITIONS P. Venkateswarlu p 95–106 refs (See N68-20505 10-26)

5. ELECTRON PARAMAGNETIC RESONANCE OF Mn^{2+} IN $(NH_4)SO_4$ SINGLE CRYSTAL B. V. R. Chowdari and P. Venkateswarlu p 107–109 refs (See N68-20506 10-26)

6. RECENT WORK ON TRANSPORT PROPERTIES OF METALS T. V. Ramakrishnana p 135–143 refs (See N68-20507 10-26)

7. ORBITAL PARAMAGNETISM IN SUPERCONDUCTORS R. Vijayaraghavan (Tata Inst. of Fundamental Res.) p 144–151 refs (See N68-20508 10-26)

8. FERRIMAGNETISM OF MANGANESE COBALT CARBIDE N. S. S. Murthy, R. J. Begum, C. S. Somanathan, B. S. Srinivasan, and M. R. L. N. Murthy (Bhabha Atomic Res. Centre) p 152–157 refs (See N68-20509 10-26)

9. EFFECTIVE MASS OF THE POSITRON IN METALS C. K. Majumdar (Tata Inst. of Fundamental Res.) p 187–195 refs (See N68-20510 10-26)

10. POSITRON ANNIHILATION IN CONDENSED MEDIA G. Chandra, V. G. Kulkarni, R. G. Lagu, and B. V. Thosar (Tata Inst. of Fundamental Res.) p 196–206 refs (See N68-20511 10-26)

11. RELAXATION OF AN INTERACTING SYSTEM OF RADIATION AND MATTER J. Premanand (Tata Inst. of Fundamental Res.) and D. L. Falkoff (Brandeis Univ.) p 211–216 refs (See N68-20512 10-24)

12. ASYMMETRY PARAMETERS FROM THE CHLORINE NUCLEAR QUADRUPOLE RESONANCE SPECTRA OF SOME ORGANIC COMPOUNDS P. T. Narasimhan p 244–246 refs (See N68-20513 10-06)

13. SEMICONDUCTION IN RARE EARTH OXIDES G. V. Chandrashekharan, P. N. Mehrotra, G. V. S. Rao, E. C. S. Rao, and C. N. R. Rao p 250–251 (See N68-20514 10-06)

N68-20502 National Physics Lab., New Delhi (India). Basic Physics Div.

THE THERMAL CONDUCTIVITY OF A POLYCRYSTALLINE ROD OF NICKEL–ZINC FERRITE AT LIQUID HELIUM TEMPERATURES

M. S. R. Chari and N. S. Natarajan *In* Indian Inst. of Tech. Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 1–30 refs (See N68-20501 10-26)

The absolute temperature scale of two salts used for magnetic cooling was determined by measuring the susceptibility of the salt with a pair of mutual inductance coils and computing the magnetic temperature. Measurements were also made of the gamma ray anisotropy of an ensemble of cobalt-60 nuclei oriented in a single crystal of metallic cobalt, which is in thermal equilibrium with the salt. Electrical conductivity and Hall coefficient measurements were made of stoichiometric thallium selenide, and experimental data are presented on the thermal conductivity of a polycrystalline rod of nickel–zinc ferrite at liquid helium temperatures. Findings are also reported on the temperature variation of capture cross sections for holes at doubly negatively-charged cobalt sites in n-type germanium; on the thermal transport properties of n-type germanium at low temperatures; and the optical absorption of CO^{2+} in crystals. M.G.J.

N68-20503 Tata Inst. of Fundamental Research, Bombay (India).

BILINEAR ELECTRODYNAMICS OF A SUPERCONDUCTOR

Sudhanshu S. Jha *In* Indian Inst. of Tech. Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 31–43 refs (See N68-20501 10-26)

Linear and bilinear electrodynamic concepts are discussed in relation to the case of a normal metal and the case of a metal in the superconducting state. It is shown that the problem of electrodynamics of a medium is divided into two parts: the distribution of charge and current densities in the medium in the presence of an arbitrary vector potential $\vec{A}$; and the use of this information to solve Maxwell's equations to find $\vec{A}$ itself. Phenomenologically, in the case of linear electrodynamics, concepts such as susceptibility, dielectric constant, and conductivity are introduced. In bilinear electrodynamics, phenomenological functions are introduced as coefficients of possible bilinear terms in the vector potential. In terms of these functions, Maxwell equations can be solved. An assessment is made of the fundamental physical process involved in calculating the linear and bilinear induced current densities in perturbation theory, in order to delineate the difference in the electromagnetic properties of a metal in normal and superconducting states. M.G.J.

N68-20504 Allahabad Univ. (India). Dept. of Physics.

CRITICAL FIELDS OF H_{c2} AND H_{c3} OF THIN FILM TYPE. 2: SUPERCONDUCTORS

J. S. Rajput and A. K. Gupta *In* Indian Inst. of Tech. Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 44–47 refs (See N68-20501 10-26)

A solution is presented to the Gorkov equations for a thin superconducting film to an arbitrary order, with the energy level quantization of single particle states in thin films explicitly taken into account. The Fe^{19} magnetic resonances in FeF_3 were studied, and preliminary results on the width and shifts of the resonances as functions of temperature and field are presented. Investigations were conducted on P^{31} resonances in some diamagnetic and paramagnetic polycrystalline phosphates. The measured spin-lattice relaxation time and line-width values at room temperature and at 16 Mc/s are tabulated. Mössbauer relaxation spectra observations of Sn^{119} in paramagnetic rare earth–tin intermetallic compounds showed the effects of the long relaxation times of the S-state rare earth ions Eu^{2+} and Gd^{3+} at neighboring nonmagnetic SN atoms. Data are included on the Fe^{57} Mössbauer effect in $SrTiO_3$, and on Mossbauer studies of the crystal field splittings in Fe^{2+} tutton salts, and of chalcopyrite crystal. Critical fields, H_{c2} and H_{c3}, of thin film superconductors are calculated. M.G.J.

N68-20505 Indian Inst. of Tech., Kanpur. Dept. of Physics.

ELECTRON PARAMAGNETIC RESONANCE IN SINGLE CRYSTALS AND PHASE TRANSITIONS

Putcha Venkateswarlu *In its* Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 95–106 refs (See N68-20501 10-26)

Electron paramagnetic resonance (EPR) studied were conducted on single crystals of KH_2PO_4, KNO_3, NH_4Br, $(NH_4)_2SO_4$, and K_2SO_4 by doping these crystals with magnetic ions like Fe^{3+}, Mn^{2+}, and Cu^{2+}. Plots depict the EPR spectra and the superhyperfine structures, and variations of fine structure parameters as a function of temperature. Among the findings reported are: (1) The EPR spectrum of Cu^{2+} in NH_4Br at room temperature indicates that some Cu^{2+} ions are substituted for $(NH_4)^+$ ions and become associated with second neighbor $(NH_4)^+$ ion vacancies; the site symmetry axis is then along [110]. (2) In the EPR spectrum of Mn^{2+} in K_2SO_4 single crystals, the Mn^{2+} is found to substitute β–K^+ ions and become associated with first, second, and third neighbor β–K^+ ion vacancies. M.G.J.

N68-20506 Indian Inst. of Tech., Kanpur. Dept. of Physics.

ELECTRON PARAMAGNETIC RESONANCE OF MN^{2+} IN $(NH_4)_2SO_4$ SINGLE CRYSTAL

B. V. R. Chowdari and Putcha Venkateswarlu *In its* Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 107–109 refs (See N68-20501 10-26)

The parameters are listed for the paramagnetic resonance spectra of divalent manganese in single crystals of ammonium sulfate in the paraelectric phase, and lattice defects such as positive ion vacancies are noted. A detailed study was conducted of the electon spin resonance (ESR) spectrum of dibarium cupric formate tetrahydrate (DBCF), $Ba_2Cu(HCOO)_6 \cdot 4H_2O$, at different temperatures. The quadrupole interaction was measured, and forbidden $\Delta M_S = \pm 1$, $\Delta M_I = \pm 1$ lines were detected. A temperature variation of the spin-Hamiltonian parameters is also discussed. The Cu^{++} ESR line shape in $CuSO_4 5H_2O$ powder was analyzed, and the g-tensor was determined. Consideration is also given to an optical absorption band which has paramagnetic centers associated with it in Cd-doped additively colored KBr crystals. Findings are reported on the ESR investigations of copper diethyldithiophosphate in chloroform, and it is shown how the ligand, $((dtp)_2)$ affects the nature of the bond with the central metal

atom. Tabulated data are included to show the line widths obtained from $Cu(dtp)_2$ in chloroform solution; viscosity data for the temperature range 60°C to −10°C were used for the calculations. M.G.J.

N68-20507 Indian Inst. of Tech., Kanpur. Dept. of Physics.
RECENT WORK ON TRANSPORT PROPERTIES OF METALS
T. V. Ramakrishnana *In its* Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 135–143 refs (See N68-20501 10-26)

Transport phanomena theories are outlined, and several applications are discussed. Equations based on perturbation theory are derived, and ways of checking their accuracy are described. Attention is centered on (1) a many-body perturbation theory describing the metallic electron–ion system, (2) extending electron–electron interactions to all orders in perturbation theory, (3) electron–phonon interaction for describing ionic motion at low temperatures, (4) calculating the higher order term for electrical conductivity on the basis of the microscopic theory, and (5) the pseudopotential model. It is suggested that some changes are required in the basic transport theory. M.G.J.

N68-20508 Tata Inst. of Fundamental Research, Bombay (India).
ORBITAL PARAMAGNETISM IN SUPERCONDUCTORS
R. Vijayaraghavan *In* Indian Inst. of Tech. Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 144–151 refs (See N68-20501 10-26)

Measurements were made of the Knight shift in a superconductor to obtain data on the temperature dependence of the spin paramagnetism. Fine particles of V_3Si and V_3Ga were used, which were small enough to permit flux penetration at fields of 14 kilogauss. The susceptibility and the shifts in V_3Ga at various temperatures are tabulated (T_c=16.5°K). The finding indicate: (1) The change in the Knight shift below T_c corresponds to a larger internal field, in striking contrast to the behavior of Sn, Hg, and Al where a small reduction of about 30% was observed in the superconducting region. (2) The change is in the positive direction, opposite to diamagnetic shielding resulting from partial flux exclusion. (3) The magnitude at V^{51} and Ga^{71} sites are different and hence the result is microscopic. (4) The shift is more positive at T→0 than it is at any temperature in the normal state. It was concluded that in transition metals there is an orbital contribution to the susceptibility which is nearly equal in magnitude to the spin susceptibility. M.G.J.

N68-20509 Bhabha Atomic Research Centre, Bombay (India).
FERRIMAGNETISM OF MANGANESE COBALT CARBIDE
N. S. Satya Murthy, R. J. Begum, C. S. Somanathan, B. S. Srinivasan, and M. R. L. N. Murthy *In* Indian Inst. of Tech. Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 152–157 refs (See N68-20501 10-26)

Using both polarized and unpolarized neutrons, the magnetic structure of $(Mn,Co)_4C$ was examined. The data analyses show that manganese cobalt carbide has a cubic, ferrimagnetic structure, consisting of two magnetic sublattices which are parallel and directed equally along the three cube edges. Experiments were conducted to determine paramagnetic scattering of neutrons in chromium tribromide; the final corrected energy distribution was found to be Gaussian. Preliminary studies are reported on the use of both polarized and unpolarized neutrons to determine spin arrangement in three spinels: $Mg_{0.5}Mn_{0.5}Fe_2O_4$, $Zn_{0.5}Ni_{0.5}Fe_2O_4$, and Co_2TiO_4. The transformation properties of the ferromagnetic Green's function is shown, based on the group theoretical analysis of the underlying symmetry of the crystal. A mechanism is proposed which leads to direct spin-lattice coupling via the magnetic field associated with the transverse optical mode. An expression for two-phonon spin-lattice relaxation time, based on this coupling mechanism, is derived. Summary information is included on the self-consistent calculation of the dynamic polarizability of the He atom. M.G.J.

N68-20510 Tata Inst. of Fundamental Research, Bombay (India).
EFFECTIVE MASS OF THE POSITRON IN METALS
Chanchal K. Majumdar *In* Indian Inst. of Tech. Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 187–195 refs (See N68-20501 10-26)

An overview is presented on the theoretical calculation of the effective mass of the positrons in metals and its measurement, and the complete disagreement between theory and experiment is discussed. The theory of the experiment is described, and it is pointed out that the theoretical calculations are based on well-known reliable procedures of solid state physics and many-body theory. The experimental data are assessed, and the first principle calculations of the effective mass are examined. It is concluded that while the theoretical calculations seem to be quite reliable, the quality of the experimental data is not particularly good. M.G.J.

N68-20511 Tata Inst. of Fundamental Research, Bombay (India).
POSITRON ANNIHILATION IN CONDENSED MEDIA
Girish Chandra, V. G. Kulkarni, R. G. Lagu, and B. V. Thosar *In* Indian Inst. of Tech. Proc. of the Nucl. Phys. and Solid State Phys. Symp. 1967 p 196–206 refs (See N68-20501 10-26)

Expressions are derived for the slow component (I_2) and the three photon annihilations (I_3) in terms of the decay constants of the various modes of annihilation. A phenomenological model is presented, in which I_2 and lifetime (T_2) is related to the properties of the medium. The values of T_2 and I_2 were obtained for various amorphous media, liquids, polymers, and some single crystals. The results are shown graphically, with I_2 and I_3 plotted against T_2. A correlation between I_2 and T_2 is reported. Several examples are given to illustrate the sensitivity of mesonic X-ray measurements to the nature of molecular binding. M.G.J.

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N68-19977# Air Force Systems Command, Edwards AFB, Calif. Air Force Rocket Propulsion Lab.
PROPELLANT SPECIFICATIONS PREPARATION AND USE
Forrest S. Forbes Oct. 1967 50 p refs Presented at the 61st Natl. Meeting of the Am. Inst. of Chem. Engr., Houston, Tex., 21 Feb. 1967
(AFRPL-TR-67-256; AD-664871)

The specification is the key document that establishes the technical requirements for propellant procurements. These requirements are dictated by the needs of the various rocket applications, with due consideration given to the manufacturing ability of the suppliers. The specification also contains quality assurance provisions that detail the sampling techniques and analytical procedures to be used to insure that the propellant conforms to the specified requirements. Propellant specifications are prepared by the cognizant technical laboratory, and authenticated annually for the procuring activity. Specifications are continually revised and updated as required by the rocket community. Examples are presented showing the rationale for the establishment of specific requirements and analytical methods for several current propellants. Author (TAB)

N68-20087# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.
THERMODYNAMIC PROPERTIES OF GASES IN PROPELLANTS. SOLUBILITIES OF HE, N_2, AND AR IN HYDRAZINE, METHYLHYDRAZINE, AND UNSYMMETRICAL DIMETHYLHYDRAZINE, AUGUST 1966–SEPTEMBER 1967

Elfreda T. Chang, Nev A. Gokcen, and Talmadge M. Poston Oct. 1967 23 p refs
(Contract F04695-67-C-0158)
(TR-0158(3210-10)-2; SAMSO-TR-68-23; AD-664885)

Solubilities of He, N2, and Ar in liquid hydrazine, methylhydrazine, and unsymmetrical dimethylhydrazine were measured at various pressures and temperatures. The results show that Henrys law is obeyed and the standard change of Gibbs energy is linear in temperature. The standard heat of solution and the entropy of solution were obtained, and the Gibbs energy was expressed as a linear function of temperature. The change in the solubility of a chosen gas from one solvent to another has been correlated by using the Lennard-Jones 6-12 potential with the assumption that the solute interacts with a hard core studded with H atoms. The functional forms of (Gibbs energy) = (heat of solution) - T(entropy of solution) for He, N2, and Ar in symmetrical dimethylhydrazine have been obtained from such correlations, and the method is shown to be useful for similar gas-liquid systems. It is shown that (a) the changes in the solubilities follow the changes in the dipole moments of liquids and (b) the entropy of solution varies linearly with the logarithm of mol fractions of solutes in methylhydrazine and in unsymmetrical dimethylhydrazine but not of solutes in hydrazine. Author (TAB)

N68-20402# Rocket Propulsion Establishment, Westcott (England).
ELDO FUTURE PROGRAMMES: COMPARISON OF HIGH ENERGY PROPELLENTS FOR UPPER STAGES OF ELDO 'B' SPACE VEHICLE LAUNCHER
Jun. 1964 42 p refs Prepared for ELDO *Its* Prelim. Study No. 3
CFSTI: HC $3.00/MF $0.65

Bipropellants and tripropellants are investigated for use in ELDO B launch vehicle high energy upper stages by comparing the effects on stage performance in terms of payload fraction, velocity increment capabilities, engine and storage characteristics, toxicity and hazards which leads to estimating the relative costs entailed. It is concluded that the majority if not all of the currently foreseen mission requirements could be met by an ELDO A boost stage with one or both of the upper stages replaced by one or more stages utilizing oxygen/hydrogen engines. ESRO

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magneto-hydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N68-19567 National Aerospace Lab., Tokyo (Japan).
EXPERIMENTAL STUDIES ON THE PRIMARY ZONE OF HIGH-INTENSITY COMBUSTORS
Teikichi Otsuka, Kunio Suzuki, Tetsuro Aiba, Asagoro Ishii, and Taiki Hirose 1967 42 p refs In JAPANESE; ENGLISH summary
(NAL-TR-143) CFSTI: $3.00

As a part of a general research programme for high-intensity combustors of turbo-jet engines, the characteristics of the primary combustion zone were investigated. To meet the requirements for a high-intensity combustor, a large quantity of fuel should be supplied at a state of high air-loading of the combustor; however, an increase of the supplied fuel deteriorates the combustion efficiency. This lower efficiency is connected not only with the increase of thermal loading but also with the deficiency in holding a stable flame in the primary zone. In order to attain high performance of an annular-type combustor by improvement of the air-swirler, several models of swirlers were studied. The flow patterns and flame-holding characteristics behind the isolated swirlers were observed; and several tentative devices were applied to the model swirlers. A combined model with three swirlers was tested to examine the mutual interference between the swirlers, as well as the effects of the liner wall and the influence of air-holes of the liner on the swirler characteristics. The information from these investigations was checked by tests of complete box-type and annular-type combustor models installed with these model swirlers: results showed that those preliminary investigations were most advantageous in developing high performance combustors. Author

N68-19581*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OUT-OF-THE-ECLIPTIC-PLANE PROBE MISSION EMPLOYING ELECTRIC PROPULSION
Frank J. Hrach Washington Apr. 1968 35 p refs
(NASA-TN-D-4455) CFSTI: HC $3.00/MF $0.65 CSCL 21C

Measurements out of the ecliptic plane are necessary in the study of the Sun and heliocentric space. The present analysis investigates the use of a combined propulsion system to accomplish the out-of-the-ecliptic-plane probe mission. In the combined propulsion system studied herein, energy beyond Earth-escape energy is given to the vehicle by a booster, after which a low-thrust electric propulsion system begins operation. The chemical boosters considered are the Atlas–Agena and the Atlas–Centaur. Three values of electric propulsion system specific powerplant mass are examined, 50, 100, and 150 pounds per kilowatt jet. Results are presented for missions to final heliographic inclinations from 25° to 45°. The basic mission profile considered is one in which the distance from the Sun to the vehicle is held constant at a value of 1 astronomical unit, and in which the propulsion is terminated before the argument of latitude of the trajectory reaches 90°. The effects of variations from the basic profile are investigated. Author

N68-19708*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL EVALUATION OF SEVERAL ADVANCED ABLATIVE MATERIALS AS NOZZLE SECTIONS OF A STORABLE-PROPELLANT ROCKET ENGINE
A. J. Pavli Washington Apr. 1968 23 p refs
(NASA-TM-X-1559) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Eighteen ablative materials were evaluated for their relative erosion resistance in test firings of 22 nozzles in a storable-propellant engine of a 1.2-inch (3.05-cm) diameter throat at a chamber pressure of 100 psia (689.5 kN/m^2). The materials investigated were the phenolic, polyimide, phenolic plus polyamide, epoxy novalac, and phenyl-silane resins, reinforced with silica, quartz, and carbon-silica fibers. Quartz reinforcement was superior to silica with the three resins tested. The lower erosion rate is attributed to the higher melting temperature of quartz. Carbon-silica reinforcement exhibited the highest erosion rate. Its relatively poor performance is attributed to the rapid oxidation of the carbon. Ablatives made of phenolic resin had lower erosion rates than all other resins tested. Erosion at mixture ratios of 1.6 was greater than at mixture ratios of 2.0. Nozzle convergent entrance angle, throat radius of curvature, and source or resin supplier had no apparent effect on erosion resistance. A slight effect of fabrication technique on erosion was detected. Author

N68-19744*# Little (Arthur D.), Inc., Cambridge, Mass.
STATISTICAL DERIVATION OF DESIGN CRITERIA FOR LIQUID ROCKET COMBUSTION INSTABILITY Final Report
E. K. Bastress, G. H. Harris, and I. Miller Dec. 1967 135 p refs
(Contract NASw-1236)
(NASA-CR-72370) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The objective of this program was the establishment of criteria for the design of stably operating liquid propellant rocket engines by means of a systematic analysis of existing test data. In this analysis, relationships were sought between engine design variables, operating variables, and stability characteristics. The results of theoretical and experimental studies of combustion instability were used as guides in seeking these relationships. The results of this program provide a comprehensive description of past experience with combustion instability in various engine types. The suggested design approach offers a means for utilizing this experience to avoid development of new engines which are prone to instability. Author

N68-19831*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 6: SOLID-PROPELLANT ROCKET SYSTEMS
Joseph F. McBride Washington 1968 20 p Presented at the Lewis Aerospace Explorers, Cleveland, 1966–1967
(NASA-TM-X-52393) CFSTI: HC$3.00/MF$0.65 CSCL 21H

A brief description of a solid rocket is given, and the functions and purposes of the case, nozzle, igniter, and insulation are delineated. The grain mixture and design of solid propellants are discussed along with the burning processes of propellant combustion. Burning rate and thrust equations are derived, and some major problems in solid rocket propulsion are mentioned. Consideration is also given to the steering mechanisms, performance, and safety precautions involved in solid-propellant rocket systems. B.S.D.

N68-19832*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 20: ELECTRIC PROPULSION
Harold Kaufman Washington 1968 24 p Presented at the Lewis Aerospace Explorers Conf., Cleveland, 1966–1967
(NASA-TM-X-52407) CFSTI: HC$3.00/MF$0.65 CSCL 21C

A brief summary is presented on the basic concepts of electric propulsion and the men responsible for its birth. The basic operating characteristics are given on electrothermal thrusters, electromagnetic thruster, and an electrostatic thruster, and the basic operations of a turboelectric power plant are delineated. An assessment is made of the use of electric propulsion systems for various space missions, and the theoretical performance of nuclear and electric propulsion systems are compared. B.S.D.

N68-19833*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 5: MATERIALS
William D. Klopp Washington 1968 20 p Presented at the Lewis Aerospace Explorers Conf., Cleveland, 1966–1967
(NASA-TM-X-52392) CFSTI: HC$3.00/MF$0.65 CSCL 21H

Materials problems directly affecting space propulsion systems are described, with particular attention given to the problems associated with uncooled nozzles for both solid and liquid propellant rockets. Potentially suitable materials for use in the critical throat region are identified as (1) the refractories, characterized by high melting points in the 4000° to 6000°F range, and (2) the ablatives, which absorb heat from the gas stream by chemical reactions as well as by melting and vaporizing. Materials evaluation criteria are discussed, and the two major parameters to be measured during test firings are cited as the temperature distribution in the nozzle, and the gas pressure in the combustion chamber. Test data are included on two experimental programs conducted to determine the behavior of several nozzle materials in two different uncooled motors. Consideration is also given to refractory–ablative combinations for achieving good heat-resistance in the nozzle. Crack propagation in large welded structures is discussed, along with the development of lightweight, tough tank materials for containment of cryogenic fuels. M.G.J.

N68-19834*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 2: PROPULSION FUNDAMENTALS
James F. Connors Washington 1968 19 p refs Presented at Lewis Aerospace Explorers Conf., Cleveland, 1966–1967
(NASA-TM-X-52389) CFSTI: HC$3.00/MF$0.65 CSCL 21H

Some basic fundamentals of rocket engine propulsion are considered. They include fundamental design criteria, factors which influence performance, and how thrust is derived from the hot jet issuing from the engine. Newtons second and third laws of motion are employed to illustrate the basic concepts of thrust. Relationships are also given for rocket engine parameters such as specific impulse and characteristic exhaust velocity. Some of the pertinent flow mechanisms in a nozzle are discussed in relation to convergent-divergent nozzle, variable-area nozzle, free expansion nozzle, and the basic rocket equation is derived. B.S.D.

N68-20064*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL INVESTIGATION OF REACTION CONTROL, STORABLE BIPROPELLANT THRUSTORS
R. James Rollbuhler Washington Apr. 1968 35 p refs
(NASA-TN-D-4416) CFSTI: HC$3.00/MF$0.65 CSCL 21H

In order to evaluate the performance of low-thrust, chemical bipropellant rocket thrustors for possible applications in spacecraft reaction control systems, an experimental investigation was conducted with readily available thrustors. The thrustors were designed for a thrust of less than 5 pounds force (22.2 N), combustion-chamber pressures of 100 pounds per square inch absolute (68.9 M/cm^2) or less, and for use with nitrogen tetroxide—hydrazine-type propellants. A high instrumented altitude test facility was used to test each of the thrustors over a range of test durations and oxidizer to fuel ratios. The maximum specific impulse obtained was 262 pounds force per pound mass per second (2570(N)(sec)/kg), and the maximum characteristic velocity was 5200 feet per second (1588 m/sec). Total impulses were measured for run times as short as 10 milliseconds. The average value of the specific impulse, at minimum run times, was about 25 percent of the maximum specific impulse for the same thrustor. Also reported are response times and combustor-wall temperatures. Author

N68-20121*# Hughes Research Labs., Malibu, Calif.
HIGH-TEMPERATURE LM CATHODES FOR ION THRUSTORS Summary Report, 1 Jun. 1966–31 Jul. 1967
W. O. Eckhardt, K. W. Arnold, G. Hagen, J. Hyman, Jr., J. A. Synder et al 31 Jul. 1967 73 p refs
(Contract NASw-1404)
(NASA-CR-93771) CFSTI: HC$3.00/MF$0.65 CSCL 21C

Liquid-Metal (LM) cathodes of annular geometry have been satisfactorily operated in electron-bombardment thrustors at temperatures up to 300°C. Analysis is presented which demonstrates that this temperature is sufficiently high to permit rejection of waste discharge heat from the thrustor shell at a temperature of 200°C or more. This capability provides an independance of the cathode from the thermal constraints of actual thrustor operation in space, whether these arise from peripheral clustering or from solar incidence. We have demonstrated source energies per ion as low as 400 eV/ion at 87% mass utilization in a 20-cm thrustor with a cathode temperature of 250°C. Furthermore, stable LM cathode operation has been demonstrated in the neutralizer current range with very attractive electron-to-atom emission ratios (50 and better) and power expenditures (≈20 eV/electron), at temperatures close to the equilibrium temperature of a neutralizer which is cooled only by radiation from its face. Author

N68-20186*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
SCALE 1/14.2 INVESTIGATION OF SUBMERGED NOZZLE FOR SL-3 260-INCH SOLID ROCKET
Reino J. Salmi and James J. Pelouch, Jr. Washington Apr. 1968 12 p refs Presented at the 2d AIAA-ICRPG Solid Propellant Conf., Anaheim, Calif., Jun. 1967
(NASA-TM-X-1546) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The original submerged nozzle configuration for the SL-3 260-inch solid propellant rocket was modified to provide additional insulation and protection against the erosive effects of hot exhaust gases in the annular channel between the submerged nozzle lip and the rocket aft-end casing. Tests of the modified nozzle design indicated that the circumferential flow velocities in the annular channel were lower for the modified nozzle than for the original configuration for the case of an unburned or 100-percent grain. For the case of the 34-percent regressed grain, which reduced the flow velocities in the annular channel, flow Mach numbers approximately equal to those of the original nozzle were obtained with the modified nozzle. Author

N68-20187*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
DIVERGENT-FLOW CONTACT-IONIZATION ELECTROSTATIC THRUSTOR FOR SATELLITE ATTITUDE CONTROL AND STATION KEEPING
Walter C. Lathem and John F. Staggs Washington Apr. 1968 25 p refs
(NASA-TN-D-4420) CFSTI: HC $3.00/MF $0.65 CSCL 21C

A divergent-flow contact-ionization electrostatic thrustor is described herein. This thrustor performed well at thrust levels between 0.89 and 1.56 millinewtons, a range that is applicable to satellite attitude-control and station-keeping missions. Power efficiencies up to 45 percent (excluding vaporizer and neutralizer powers) were obtained for operation at specific impulses from 5000 to 8000 seconds. No damage due to primary ion impingement was detected in about 200 hours of running. Accelerator drain currents were typically less than 2 percent of the beam current. Computer studies indicated an accelerator electrode lifetime in excess of 20,000 hours. Experimental data verified the computer predictions for electrostatic beam deflection up to about 15°. This deflection produced a component of thrust normal to the center plane of up to 30 percent of the total thrust of an undeflected beam. Author

N68-20266# Royal Aircraft Establishment, Farnborough (England). Space Dept.
ELDO FUTURE PROGRAMS: A PRELIMINARY STUDY OF THE PERFORMANCE AND DESIGN OF APOGEE MOTOR STAGES FOR THE ELDO 'A' LAUNCHING VEHICLE
Mar. 1964 121 p refs *Its* Preliminary Study No. 1.1 Prepared for ELDO
(RAE/SPA/L/C.917) CFSTI: HC $3.00/MF $0.65

The results of many relevant studies of the apogee motor stage for ELDO future programs carried out in the United Kingdom are summarized. The ability of a simple apogee stage, used with ELDO A vehicle to inject worthwhile payloads with acceptable accuracy into orbits of interest for a satellite communication system is demonstrated. Two basic types of apogee stages are singled out for further studies: one type is a spin stabilized uncontrolled stage using a solid propellant motor, and the other is a controlled stage using a liquid propellant motor. Comparisons are based on design features, development testing, time scales, costs, thorough examination of error sources. ESRO

N68-20307# Hawker Siddeley Dynamics, Ltd., Stevenage (England). Space Div.
HIGH ENERGY UPPER STAGES FOR ELDO VEHICLES
G. W. Childs and D. Stott 1967 38 p Presented at the ELDO Symp. on Propulsion, Paris, 10–12 Oct. 1967 Submitted for publication
(ELDO/SP(67)-6) CFSTI: HC $3.00/MF $0.65

Describes the design characteristics and performance of high energy liquid hydrogen/liquid oxygen engines and considers their application as upper stages to possible future ELDO launch vehicles. Reviews work already done and outlines a development program. Author (ESRO)

N68-20321# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
REVIEW OF THE STATE OF THE ART AND TECHNOLOGICAL PROGRESS IN THE FIELD OF HYBRID PROPELLANTS [REVUE DE L'ETAT ACTUEL DES CONNAISSANCES ET DES PROGRES TECHNIQUES REALISES SUR LES LITHERGOLS]
M. Barrere, A. Moutet, B. Crampel, and J. F. Lieberherr Apr. 1966 212 p refs In FRENCH Prepared for ELDO
(Contract CTR-17/3/4)
(ONERA-NT-1/1233-EY) CFSTI: HC $3.00/MF $0.65

Reviews state of the art in the field of hybrid propellants and their application to rocket engines in view of their use in European space programs. Combustion physics and related problems are discussed at some length. ESRO

N68-20392# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
ADVANCED HYBRID PROPELLANTS (SYSTEMES HYBRIDES AVANCES)
Bernard Crampel 1967 51 p refs In FRENCH; ENGLISH summary Presented at the ELDO Symp. on Propulsion, Paris, 10–12 Oct. 1967 Submitted for publication
(ELDO/SP(67)-7) CFSTI: HC $3.00/MF $0.65

Hybrid propulsion systems have entered, during the last few years, a faster development phase. The variety of possible applications studies made as well in Europe as in the United States, shows the increasing attention paid to this type of propulsion system. The major features of hybrid motors are, in addition to their energetic performance, maneuvering possibilities, high operation safety and the possibility of applying simple techniques to low cost development of high thrust motors. Author (ESRO)

N68-20400# Societe l'Air Liquide, Sassenage (France). Centre d'Etudes Cryogeniques.
INTEGRAL TANKS OF THE CRYOGENIC STAGE H3,5 [RESERVOIRS STRUCTURAUX DE L'ETAGE CRYOGENIQUE H3,5]
J. Menard and M. Segel 1967 25 p refs In FRENCH; ENGLISH summary Presented at the ELDO Symp. on Propulsion, Paris, 10–12 Oct. 1967 Submitted for publication
(ELDO/SP(647)-4) CFSTI: HC $3.00/MF $0.65

Describes the development of integral tanks, which combine the functions of propellant containers and transmitters of compressive and bending stresses, for use as an upper stage H 3.5 (3.5 tons propellant) of cryogenic H2/O2 rocket designed for short duration mission without relight. Discusses the technology and testing of materials, their mechanical characteristics and thermal insulation problems, as well as the behaviour and transfer of propellants, low temperature metrology, qualification trials and equipment. The H 3.5 stage was conceived in 1964 for an improved version of the French national launcher. Author (ESRO)

N68-20493# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
PROSPECTIVE EVALUATION OF HYBRID PROPELLANT ROCKET ENGINES FOR ELDO APPLICATIONS [EVALUATION PROSPECTIVE DE L'INTERET DES MOTEURS A LITHERGOL POUR L'ELDO]

P. Duban Apr. 1966 106 p In FRENCH Prepared for ELDO (Contract CTR-17/3/4)
(ONERA-NT-2/1233-EY) CFSTI: HC $3.00/MF $0.65

Problems concerning hybrid propellant rocket engines are thoroughly examined in view of an evaluation of their use in future European space programs and especially for ELDO launch vehicles. ESRO

N68-20573# School of Aerospace Medicine, Brooks AFB, Tex.
MANNED PROPULSION DEVICES AND THEIR APPLICATION ON EARTH AND IN SPACE
Leonard M. Seale and Jerome E. Emerson *In its* Lectures of Aerospace Med., 6th Ser. 1967 p 481-519 refs (See N68-20545 10-04)

This paper was directed at summarizing the major studies on personal propulsion devices which have been completed in the last decade. Primary emphasis was placed on the Small Rocket Life Device (SRLD) concept developed by Bell Aerosystems Company and extrapolating it's performance potential and control concepts to simple mobility systems for use on the lunar surface and in earth orbit. The data presented indicate that the primary means of flight control used in flying the earth SRLD incorporates thrust vector control; i.e., the operator maintains attitude and translational control of the vehicle by rotating his thrust vector relative to the system c.g. The operator's variable damping characteristics serve to dampen any resultant oscillations. Extrapolation of the SRLD capabilities to operation over the lunar surface clearly indicated operational feasibility. The application of personal propulsion devices employing thrust vector control under orbital conditions was briefly discussed. It was concluded that systems employing some form of augmentation are required if a wide range of orbital support functions is to be accomplished. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N68-19806 Cornell Univ., Ithaca, N. Y.
THE INTERPRETATION OF ATMOSPHERIC FLUORESCENCE SIGNALS FROM MULTI-JOULE COSMIC RAY AIR SHOWERS
Edward Beynon Jenkins (Ph.D. Thesis) 1966 212 p
Available from Univ. Microfilms: HC $9.70/MF $3.00 Order No. 67-1470

Past observations of very large air showers have indicated the existence of cosmic ray primaries having energies which reach as high as 10^{19} to 10^{20} eV. However air showers of such magnitude occur infrequently within the limited area covered by conventional particle detection arrays, and for this reason the exploration of the energy region beyond one joule has been difficult. An investigation has been made on the feasibility of an experimental approach which is capable of registering large air showers at a distance of up to ten or fifteen kilometers away from the apparatus. The method of detection embodies the nighttime observation of a weak fluorescence radiation emitted isotropically from nitrogen molecules excited by the air shower's secondary electrons. Laboratory measurements of the light yield from air undergoing particle bombardment indicate that the optical signal within 3,000 Å to 4,000 Å from a shower should be of sufficient intensity to be detectable by an apparatus of moderately ambitious design. The technique's effectiveness is chiefly limited by an obscuration of the desired signal by a photoelectron statistical fluctuation noise generated by the presence of background illumination in the night sky. A study on the relevance of various apparatus design parameters to the detection efficiency and overall counting rate is presented. Over a three year period a pilot experiment was operated in an attempt to observe actual cosmic ray events. Dissert. Abstr.

N68-19889*# Stanford Univ., Calif. Radioscience Lab.
INTERPLANETARY ELECTRON CONTENT MEASURED BETWEEN EARTH AND THE PIONEER 6 AND 7 SPACECRAFT USING RADIO PROPAGATION EFFECTS
Richard L. Koehler May 1967 124 p refs
(Contracts NSR-05-020-109; NAS2-3908; Grant NsG-377)
(NASA-CR-93777; SU-SEL-67-051; SR-1; SR-20) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Radio signals at 50 and 425 MHz are sent to deep space probes to determine the electron number density, structure, and time variability of the interplanetary medium. The electron content introduces a small difference in the time it takes the 50 and 425 MHz signals to reach the spacecraft; this time difference is caused by the frequency dependence of the velocity of propagation in a plasma. The time difference, determined from phase shift of the modulation on both signals, provides a measure of the total electron content in the path. In addition, the number of cycles of phase shift of the radio frequency carriers are counted to provide a high resolution measurement of the change in electron content along the path. Author

N68-19937*# Maryland Univ., College Park. Dept. of Physics and Astronomy.
COMMENT ON THE BIOLOGICAL EFFECTS OF COSMIC RAYS FROM NEARBY SUPERNOVAE
H. Laster Feb. 1968 5 p refs
(Grant NsG-58-60)
(NASA-CR-93745; TR-800) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Current theories describing cosmic ray propagation within the galaxy say that particles are either diffusing through the interstellar medium or moving along tortuous galactic magnetic lines. In either case, approximately three light years is taken as typical for straight line propagation of cosmic ray particles from their source; and, because of these paths, radiation would be spread over years rather than occur in a sudden burst. Therefore, the biological effect from supernovae emission is considered to be appreciably smaller than that described by Terry and Tucker, and effects on animals would probably be negligible. Based on a diffusion model with mean free paths of about three light years, an average of 40 years is estimated for a supernova explosion in 6×10^6 years that produces 25,000 roentgens and releases 10^{60} ergs. Even with 10^{51} ergs cosmic ray energy, biological effects would be appreciably reduced for all but the very closest and rarest of supernovae. Doses of 10,000 roentgens are estimated to occur once every 150 million years, with each dose spread over hundreds of years. M.W.R.

N68-20180# Stanford Univ., Calif. Inst. for Plasma Research.
A MECHANISM FOR QUASAR CONTINUUM RADIATION, WITH APPLICATION TO 3C 273B
P. A Sturrock and P. A. Feldman Dec. 1967 14 p refs
(Contract N00014-67-A-0112-0006)
(SU-IPR-215; AD-664692)

The mechanism requires a quasar model in which the central object is magnetically coupled to intergalactic space. Intergalactic plasma is accreted and flows inward, attaining supersonic speeds. The kinetic energy of this gas is converted to (relativistic) electron thermal energy at a collision-free shock front. The electron energy is rapidly radiated by the synchrotron process. The quasar 3C 273B is discussed quantitatively, and it is shown that the physical characteristics of the line-emission region and of the meter-wave radio region are consistent with those proposed for the continuum-emission region. Author (TAB)

N68-20272# European Space Research Organization, Paris (France).
SATELLITE AND ROCKET MEASUREMENTS OF CORPUSCULAR RADIATION FROM OUTER SPACE [MESURES DES RAYONNEMENTS CORPUSCULAIRES DE L'ESPACE AU MOYEN DE SATELLITES ET DE FUSEES]
Dec. 1967 30 p ref ESLAB/ESRIN Symp. held in Noordwijk, Jul. 1967
(ESRO-SP-19) CFSTI: HC $3.00/MF $0.65

The main subjects of this colloquium were galactic cosmic rays, solar plasma, channel multiplier techniques, solar flares, radiation belts and auroral particles, and satellite data systems. The complete proceedings are not being reproduced, but the present publication summarizes the outstanding features of the lectures and makes recommendations for future activities. ESRO

N68-20275# California Univ., Berkeley. Space Sciences Lab.
THE SOLAR PARTICLE EVENTS OF MAY 23 AND MAY 28, 1967
S. T. Lindgren 1 Feb. 1968 57 p refs

McMath plage region 8818 passed over the visible solar disk on May 17–31, 1967. Although it was very active from its first appearance on the eastern limb, no solar particles were detected near the earth until the evening of May 23, when three bright flares were observed in close succession at 25°–28°E. During the following build-up of the solar particle flux over ≈36 hours, the galactic cosmic ray flux >1 BeV decreased gradually by about 5%. A particle event early on May 28 was also associated with a bright flare in McMath region 8818, at 33°W. This event displayed a rapid build-up, with electrons arriving first, and an exponential decay. A smooth proton peak, 20 minutes wide, was detected on May 30 closely associated with an SSC attributed to plasma ejection from the parent flare of the May 28 event. Between the geomagnetic storms beginning on May 25 and May 30 an anomalous daily variation was observed in the cosmic ray flux >1 BeV, the time of maximum falling 7–10 hours earlier than normal. Storm time increases in the flux of galactic cosmic rays were seen on May 28. Author

N68-20293*# State Univ. of Iowa, Iowa City. Physics and Astronomy Dept.
CHARGE-EXCHANGE LIFETIMES FOR LOW-ENERGY PROTONS IN THE OUTER RADIATION ZONE AND IMPLICATIONS CONCERNING THE DENSITY OF ATOMIC HYDROGEN IN THE TERRESTRIAL EXOSPHERE
R. L. Swisher and L. A. Frank Jan. 1968 31 p refs
(Contracts NAS5-2054; Nonr-1509(06); Grant NsG-233-62)
(NASA-CR-93765; Rept.-68-3) CFSTI: HC $3.00/MF $0.65
CSCL 04A

The directional, differential intensities of protons over the energy range ≈200 eV to 50 keV injected into the outer radiation zone coincident with the initial phase of the geomagnetic storm during early July 1966 were monitored with a sensitive array of electrostatic analyzers borne on the earth-satellite OGO 3. Proton intensities are greatly enhanced throughout the outer radiation zone for L-values ≥ 3 during the main phase of this moderate magnetic storm, and the injection mechanism ceases to be effective after the storm main phase for L-values ≤ 5.5. Proton ($30 \leq E \leq 50$ keV) intensities are shown to exponentially decay with lifetimes ranging from 15 to 105 hours in substantial agreement with calculated lifetimes invoking measured charge-exchange cross-sections for protons incident upon atomic hydrogen and a model of the atomic hydrogen density in the earth atmosphere. Author

N68-20404# Bologna Univ. (Italy). Inst. of Physics.
BALLOON OBSERVATIONS OF COSMIC X-RAY SOURCES
D. Brini, U. Ciriegi, F. Fuligni, G. Vespignani, and A. F. Baseggio (La Plata Univ.) [1967] 12 p refs
CFSTI: HC $3.00/MF $0.65

The results of a balloon flight to search for X-ray sources in the 30 to 200 KeV energy range are reported. From the Crab region, a flux of 0.29 ± 0.06 quanta/cm^2 x sec, or 2.8×10^{-8} ergs/cm^2 x sec, with a power spectrum law of exponent of -2.1 ± 0.2, is found. Another emission from a sky zone located at $08^h \pm 01^h$ R.A. and $60 \times 19 \pm 10 \times 19$ D. has been discovered. Assuming a power spectrum law, the exponent results -1.3 ± 0.2, giving a flux of 0.25 ± 0.06 quanta/cm^2 x sec corresponding to 3.3×10^{-8} ergs/cm^2 x sec. The sky zone including the 1 to 10 KeV X-ray sources Cep X 1, Cep X 2, Cep X 3, Cass X 1 (A) and Lac X 1 has also been investigated. The upper limit of the flux is about 0.11 ± 0.06 quanta/cm^2 x sec corresponding to less than 10^{-8} ergs/cm^2 x sec. Author (ESRO)

N68-20442# Royal Inst. of Tech., Stockholm (Sweden). Electron and Plasma Physics Div.
TRANSPORT AND ACCELERATION OF RADIATION BELT PARTICLES
Carl-Gunne Faelthammar 15 Feb. 1968 30 p refs Presented at the Lecture, Toulouse, 21–23 Feb. 1968
(Rept.-68-04) CFSTI: HC $3.00/MF $0.65

A description is made of how the necessary transport and acceleration of particles is achieved as a result of electric and magnetic disturbances varying on a time scale of typically a fraction of an hour. Diffusion and acceleration of particles result both from electric potential fields (associated with time-dependent plasma convection in the magnetosphere), and magnetic disturbances (associated with large-scale deformation of the magnetophere). For several years the magnetic disturbances were thought to be the most important mechanism. However, there are indications that the electric potential field may be equally or even more important. The difficulties are caused by the present lack of observational data on the electric field and a conclusion may have to wait until direct electric field measurements in the magnetosphere have been performed. Author (ESRO)

N68-20447# Royal Aircraft Establishment, Farnborough (England).
ESTIMATE OF CORPUSCULAR RADIATION DOSE RATES FOR TYPICAL BLACK ARROW SATELLITES
C. J. Savage Aug. 1967 22 p refs
(RAE-TR-67208) CFSTI: HC $3.00/MF $0.65

Radiation dose rates for components positioned on the outer surface or within a Black Arrow type satellite have been estimated. Attention has been restricted to circular polar orbits in the altitude range 500 to 1900 km and to the 36000 km synchronous orbit. Author (ESRO)

N68-20487# Royal Aircraft Establishment, Farnborough (England).
SOLAR FLARE EFFECTS AND VLF RADIO WAVE OBSERVATIONS OF THE LOWER IONOSPHERE
B. Burgess and T. B. Jones Aug. 1967 23 p refs
(RAE-TR-67201) CFSTI: HC $3.00/MF $0.65

The observed changes of phase and signal amplitude of VLF radio waves, propagated over distances varying between 1000 and 10000 km, which accompany solar flares have been studied for the period 1961–1964. In general the phase of the received signal advances and the signal amplitude increases during the onset of a solar flare. However observations of the GBR transmissions at Rome (1500 km path show that for this particular path the phase of the received signal retards in contrast to all other paths studied. Assuming that the conductivity of the lower ionosphere varies exponentially with height under both quiet and disturbed conditions it is possible to evaluate the waveguide mode characteristics of VLF propagation over large distances. Using this theoretical approach it has been shown that the observations can only be interpreted if both the D region electron density profile is lowered and the gradient of ionisation density increased. The magnitude of the flare produced changes in ionisation density profiles of the lower ionosphere have been evaluated analytically from solar X-ray data.

These profile changes are consistent with the lowering of the D region and increase in ionisation gradient that is required to explain the VLF radio wave observations. Author (ESRO)

N68-20498*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SLOW ONSET TYPE PCA EVENTS AND ASSOCIATED PRE-SSC POLAR GEOMAGNETIC DISTURBANCES

Yukio Hakura and Masao Nagai (Magnetic Obs.) Mar. 1968 12 p refs

(NASA-TM-X-63140; X-641-68-85) CFSTI: HC $3.00/MF $0.65 CSCL 04A

A new type of polar geomagnetic disturbance was observed in connection with polar cap absorptions of slow onset type. A synoptic analysis of the February 10, 1958 event shows that the disturbance is an intensified S_q^R field due to an enhanced ionization produced in the ionosphere dynamo region. Protons with energies 0.1–1 Mev in the solar cosmic rays may be the cause of the disturbance. Author

N68-20526# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

STUDY OF 0,1 MEV GAMMA RADIATION IN THE EARTH'S ATMOSPHERE [ETUDE DU RAYONNEMENT GAMMA ENTRE 0,1 ET 1 MEV DANS L'ATMOSPHERE TERRESTRE]

Daniel Boclet (M.S. Thesis—Paris Univ., France) 13 Jan. 1967 87 p refs In FRENCH; ENGLISH summary

(CEA-R-3177) CFSTI: HC $3.00/MF $0.65

The present work is devoted to some of the particular problems arising in the detection and localization of sources of gamma radiation situated outside the earth's atmosphere. These weak sources can only be detected and localized if care is taken to eliminate gamma and particle radiations coming from other sources in the earth's atmosphere and in space. In order to separate the various sources of background noise, generally much stronger than the radiation under study, use is made of a directional detector whose characteristics are determined as described in the first part of the following report. The closest diffuse source considered is that constituted by the earth's atmosphere. Its detailed study will make it possible both to eliminate its effect when sources outside the earth are to be measured, and to predict the amount of secondary gamma radiation emitted by the same process in other celestial bodies, the moon in particular. Author (ESRO)

N68-20570# School of Aerospace Medicine, Brooks AFB, Tex.

PARTICLE POPULATIONS IN SPACE

Frank B. McDonald and C. E. Fichtel *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 427–439 refs (See N68-20545 10-04)

This paper summarizes present information on particle populations in space and gives a picture of the flux, composition, and energy spectra of the various types of radiation. The principal features of galactic cosmic rays are their energy and charge spectra modulation with time intervals of 11 years. After major flares solar cosmic rays arriving at earth are of much higher intensities than ordinary cosmic rays; this is attributed to the combined actions of acceleration and transit modulation in interstellar conditions. Van Allen belt radiation consists of trapped particles that spiral back and forth along the lines of force of the earth's magnetic fields, and consist predominantly of protons and electrons. G.G.

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N68-19495*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

ANALYSIS OF F AND G SUBDWARFS. 3: AN ABUNDANCE ANALYSIS OF THE SUBDWARF μ CASSIOPEIA

Judith G. Cohen Aug. 1967 14 p refs

(Grant NGR-22-024-001)

(NASA-CR-93692; Rept.-706-7) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Equivalent widths of lines with $\lambda > 4600$ Å were measured from a set of 4.5 Å/mm Palomar plates and were used in performing a model atmosphere abundance analysis of the mild subdwarf μ Cas. Comparison with solar abundances was made by computing abundances from individual solar lines using the same set of transition probabilities as was used for the subdwarf. Results of this analysis show that the iron-peak elements appear to be deficient by a factor of 4, while the α-process in μ Cas elements may be enhanced with respect to these elements. Author

N68-19516*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

"ON THE COMPOSITION OF SIRIUS" REVISITED

S. E. Strom, O. Gingerich, and K. M. Strom Feb. 1968 6 p refs

(Grant NGR-22-024-001)

(NASA-CR-93693; Rept.-801-207) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Model atmosphere analyses, using various microturbulent velocities, were performed to determine the abundances in Sirius and Vega. A (9500°, 3.7:1) model was used for Vega and a (10,000°, 4.2; 10) model for Sirius. After deriving the abundances for the two stars with assumed values for the microturbulence, the best value was determined when the abundances for the individual Fe and Ti II lines showed the least dependence on equivalent width. Results for all Fe lines are included. A repeated Sirius analysis with a solar metal composition in the opacities, and the deduced abundances differed by 25 percent or less. It was concluded that Sr, Ba, and Ni are overabundant with respect to Fe in Sirius relative to Vega and Sc, Ca, C, N, and O are underabundant with respect to Fe in Sirius relative to Vega. G.G.

N68-19559*# Volt Technical Corp., Washington, D. C.

ON THE QUESTION OF POLYGONALITY AND IRREGULARITIES OF THE SHAPE OF CERTAIN CRATERS ON THE MOON [K VOPROSU O POLIGONAL'NOSTI I NEPRAVIL'NOSTYAKH FORMY NEKOTORYKH KRATEROV NA LUNE]

V. D. Davydov 25 Mar. 1968 5 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Ser. Astron., v. 178, no. 4, 1968 p 797–799

(Contract NAS5-12487)

(NASA-CR-93660; ST-LPS-LS-10697) CFSTI: HC $3.00/MF $0.65 CSCL 03A

On the basis of 160 examples the author shows that among the quasipolygonal objects on the Moon the prevailing ones are not completely polygonal. The noted correlation between the contours of polygonal craters and the direction of breaks is discussed. The opinion that explosive disintegration of anisotropic matter must lead to isotropy of shock wave propagation within the bounds of the disintegration radius is rejected. Author

N68-19572*# Chrysler Corp., New Orleans, La. Space Div.

AAP PRELIMINARY RANGE SAFETY ANALYSIS

Jul. 1967 29 p refs

(Contract NAS8-4016)

(NASA-CR-93715; SSR-105) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Range safety data and results are presented for a Saturn IB/CSM configuration into an 81×120 n. mi. elliptical orbit and for a Saturn IB/NC configuration into a 260 n. mi. circular orbit. Orbit inclination is 50 deg with flight azimuths of 39.8 deg and

110 deg for both configurations. The S–IB stage in-plane impact containment zones, for the nose cone configuration north and southeast launches, are 31 km and 37 km long, respectively. Similar data for the CSM configuration are 46 km and 50 km, while the applicable CSM S–IVB stage impact zones are 201 km for the north launch and 168 km for the southeast launch. Since land masses are overflown, an impact and casualty probability study is conducted. Previous studies indicate the optimum Service Module propellant required is from 15,000 to 16,000 lbs. These studies also showed that payload variations are insensitive to large changes in SM propellant burned. However, a cursory examination of resulting impact data shows the amount of SM propellant can have a significant effect on IIP range. This effect should be considered in future CSM vehicle performance and range safety studies. Author

N68-19573# Kyoto Univ. (Japan). Research Inst. for Fundamental Physics.

RAPID CONTRACTION OF A PROTOSTAR TO THE STAGE OF QUASI-HYDROSTATIC EQUILIBRIUM, 1. THE CASE OF ONE SOLAR MASS WITHOUT RADIATION FLOW

Takenori Nakano, Noboru Ohyama (Hiroshima Univ.), and Chushiro Hayashi Jan. 1968 43 p refs

(RIFP-66) CFSTI: HC $3.00/MF $0.65

The evolution of an opaque protostar of one solar mass is investigated up to the onset stage of quasi-hydrostatic equilibrium by solving numerically the hydrodynamic equations of motion. The protostar is assumed to retain spherical symmetry. The dissipation of the energy of mass motion by shock waves is taken into account, but the radiation flow in the protostar is neglected because of the rapidity of the dynamics. It is found that the stellar structure at the onset stage of quasi-hydrostatic equilibrium is insensitive to the initial distributions of density and temperature in the protostar. At this onset stage the star has an isothermal and dense core and a tenuous envelope with a radius of about 200 $R_\odot$. By the shock wave an outermost envelope having a mass as small as $10^{-4}M_\odot$ is ejected from the star. Author

N68-19590*# Wisconsin Univ., Madison.

ULTRAVIOLET DAYGLOW AND STELLAR BRIGHTNESS MEASUREMENT FROM THE X-15 AIRCRAFT

Lowell R. Doherty Washington NASA Mar. 1968 22 p refs

(Grant NsG-618)

(NASA-CR-1017) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The design and operation of a two channel photometer used to obtain sky brightness data are described. These data were used in preparation for an airborne astronomical photography program using the X-15 aircraft. Four Nikon 35 mm camera bodies with motor driven film transport mechanisms were used for ultraviolet stellar photography. The optics consisted of a lens system in a barrel mount and a field flattener located immediately above the focal-plane shutter. A focal length of 108 mm was used. An interference filter was mounted in front of the lens as a limiting aperture, producing an f/5 system. A gyroscopic platform designed to provide a constant pointing direction within an rms fluctuation of one minute of arc supported the four cameras in a hatch behind the pilot's compartment. Four stars were identified on ultraviolet films taken on two flights, and daytime stellar brightness was calculated for these. E.J.S.

N68-19615*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

ADVANCED STUDIES

In its Space Programs Sum. No. 37-49, Vol. 1 for the Period Nov. 1 to Dec. 31, 1967. Flight Proj. 31 Jan. 1968 p 65–85 (See N68-19612 10-31)

A chart is presented which displays a logical sequence of investigations for the effective accomplishments of required objectives in lunar exploration. The major lines of investigation are depicted, priorities assigned to various scientific objectives, and the required instrumentation and spacecraft are tabulated. A model 1973 Venus capsule/lander configuration is depicted and mission design criteria are presented. E.J.S.

N68-19622*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LINE-OF-SIGHT VELOCITY AS AN INDICATOR OF PERICYNTHION ALTITUDE OF SELENOCENTRIC ORBITS

James Lloyd Williams Washington Mar. 1968 18 p refs

(NASA-TM-X-1508) CFSTI: HC $3.00/MF $0.65 CSCL 22C

An investigation was made to determine the feasibility of using simplified equations to predict the pericynthion of a selenocentric orbit. It was assumed that the angular rate of the line of sight with respect to a prominent lunar surface feature was available for positions along a ballistic trajectory. The equations used were derived in terms of this variable by utilizing the linearized rendezvous equations and certain parameters of a circular selenocentric orbit. The procedure used in the evaluation of these equations was to calculate the pericynthion of selected reference Hohmann trajectories and to compare the values calculated by these equations with the known reference orbit values. The results of the computations indicate that the pericynthion altitude predicted by the approximate equations generally is not accurate, and that the predicted pericynthion altitude is very sensitive to the reference orbit altitude, to the times at which measurements of the rotation of the line of sight are made, and to the length of time between the measurements of the angular rate of line of sight. Author

N68-19639*# Rensselaer Polytechnic Inst., Troy, N. Y. Materials Div.

SPATIAL NUCLEATION AND CRYSTAL GROWTH Final Report, 1 Jun. 1964–30 Sep. 1967

John B. Hudson [1967] 12 p refs

(Grant NsG-663)

(NASA-CR-93724) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Experimental measurements of energy transfer, adsorption, and nucleation phenomena in various vapor-solid systems are described along with theoretical studies of the relevance of classical nucleation and growth theories to interstellar grain formation processes. A theory has been developed on the origin of interstellar grains by nucleation of graphite particles in the atmospheres of carbon-rich stars. The critical supersaturation for nucleation of selenium on pyrex glass was measured under various experimental conditions. Static vapor and molecular beam techniques were used for visual observation of the condensed phase. A system for the measurement of gas-surface interactions by molecular beam mass spectrometric techniques is briefly described. Electron bombardment induced desorption of gases from solid surfaces is discussed. In this system, a small mass spectrometer is used to monitor the ion current resulting from the desorption of gas molecules. Static vapor-mass spectrometric techniques are presented for examining gas-surface interactions, and homogeneous nucleation in a supersonic molecular beam is described. E.J.S.

N68-19676*# North American Aviation, Inc., Downey, Calif.

GUIDANCE, FLIGHT MECHANICS AND TRAJECTORY OPTIMIZATION. VOLUME 2: OBSERVATION THEORY AND SENSORS

B. J. Miller and A. S. Abbott Washington NASA Mar. 1968 181 p refs

(Contract NAS8-11495)

(NASA-CR-1001; SID-65-1200-2, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Reported is a monograph which is designed to illustrate analytical methods used in the fields of guidance, flight mechanics, and trajectory optimization. Primary objectives are to present a comprehensive technical discussion of observation theory and sensors applicable to the navigation of boost and space vehicles. Discussed are the following: radiation theory and sensors; radiation sensing

techniques; inertial theory and sensors; observation (state vector relationships); observation errors; state determination from evenly determined data; sensor requirements imposed upon a vehicle; and criteria for selecting observables to be measured. S.C.W.

N68-19800*# Columbia Univ., New York.
ROTATIONS AND OSCILLATIONS OF A NEUTRON STAR
Wai-yin Chau (Ph.D. Thesis) 1967 106 p refs
(Grant NsG-445)
(NASA-CR-93728) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Gravitational radiation from various pulsating and rotating objects is studied using the formula obtained with the weak-field limit of general relativity. The cases of rotation and oscillation are considered and the effects of rotation on radial oscillations are investigated. Numerical estimates are made with data relevant to a neutron star and it is concluded that most of the energy a neutron star may acquire during its formation is dissipated rapidly, unless the rotation is quite slow. The various means by which rotation can be slowed down are considered, and it is concluded that whether a neutron star can bifurcate to form a non-axisymmetric Jacobi type configuration is quite uncertain, owing to a lack of knowledge of the equation of state. The problem should be considered in the framework of Post-Newtonian approximation. By making use of a variational approach, a set of equations determining the structure of a fast-rotating polytrope are obtained. The equations are solved for the case of unity polytropic index and with the assumption of axisymmetry. Author

N68-19824*# General Dynamics/Convair, San Diego, Calif.
A MONOGRAPH ON EXIT STABILITY. VOLUME 3: STRUCTURES. PART B: LOADS AND STRUCTURAL DYNAMICS
R. F. Ringland Feb. 1967 171 p refs
(Contract NAS8-11486)
(NASA-CR-61681; GDC-BTD-67-029, V. 3, Pt. B) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The state-of-the-art in linear flight control system design for launch vehicles is discussed, with attention centered on analysis in the frequency domain, where the properties of the solution to the equations of motion are inferred without actually solving the equations; and in the time domain, where simulations of the launch vehicle are used to obtain solutions to the equation. Dynamic modeling is considered, and the various criteria by which a launch vehicle flight control system may be judged are defined. The major techniques used in the preliminary design phases are described. Simplified equations of motion are derived for modes of system response in three frequency ranges: rigid body, propellant sloshing, and flexible vehicle bending. The root locus and frequency response methods of frequency domain analysis are examined, and the close relationship between the two is shown. Also considered are the design verification phase of analysis, and the correlation between analytical predictions and test results. M.G.J.

N68-19846*# California Univ., Los Angeles. Dept. of Chemistry.
ICE CAPS ON VENUS?
W. F. Libby [1967] 6 p refs
(Grants NaG-237-62; AF-AFOSR-245-67)
(NASA-CR-93741) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The Venus data obtained by the Mariner 5 and Venus 4 probes are interpreted as evidence for giant polar ice caps which hold the water which must have come out of the volcanos with the observed CO_2 on the assumption that the earth and Venus are of similar composition. Life would seem to be distinct possibility at the edge of the ice sheets. Author

N68-19907*# IIT Research Inst., Chicago, Ill. Astro Sciences Center.
TRAJECTORY OPPORTUNITIES TO THE OUTER PLANETS FOR THE PERIOD 1975–2000
B. J. Rejzer Dec. 1967 27 p refs
(Contract NASr-65(06))
(NASA-CR-93783; T-20) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Minimum energy trajectory data to the planets Jupiter, Saturn, Uranus, Neptune and Pluto are presented for each launch opportunity in the period 1975–2000. Data for launch windows of 10, 20, and 30 day are tabulated in most cases. The data consists of the launch date, characteristic and vis viva energy, hyperbolic approach velocity, communications distance and time of flight associated with each opportunity. It was found that energy requirements tend to increase rapidly as launch windows are increased and thus it is suggested that wherever possible windows to the outer planets be restricted to 20 days or less. The trajectory data presented provides an adequate advanced mission planning guide to the outer planets launch opportunities between 1975 and 2000. Author

N68-19961# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
OPTIMAL STATION KEEPING AT THE L4 LIBRATION POINT
Isaac Robert Steinberg (M.S. Thesis) Jun. 1967 88 p refs
(GGC/EE/67-10; AD-665131)

A control system is devised for maintaining a space vehicle in close proximity to one of the earth-moon triangular libration points while minimizing fuel consumption. The problem is formulated as an optimal state regulator problem of variational calculus and then modern control theory is applied. A quadratic performance criterion is used which leads to a linear feedback control system. The feedback gains are obtained by solving a matrix differential equation of the Ricatti type on a high-speed digital computer. Performance of the resulting optimal system is verified and further analyzed on an analog computer. Author (TAB)

N68-19985*# North American Aviation, Inc., Downey, Calif.
GUIDANCE, FLIGHT MECHANICS AND TRAJECTORY OPTIMIZATION. VOLUME 14: ENTRY GUIDANCE EQUATIONS
M. B. Tamburro and E. F. Knotts Washington NASA Apr. 1968 149 p refs
(Contract NAS8-11495)
(NASA-CR-1013; SID-66-1678-6, V. 14) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Theories proposed for entry guidance are summarized, and the ways in which they may be applied for a given vehicle mission combination are described. The basic entry performance interactions that must be considered when formulating a guidance system are examined, and a method of discerning between unacceptable and acceptable trajectories is introduced. Mathematical theories of entry guidance are derived in terms of paths for which closed-form solutions can be obtained, in terms of paths which are defined by a fast-time integration method, or in terms of controlling the vehicle in the neighborhood of a nominal trajectory known to exhibit desirable trajectory characteristics. The techniques used in the Gemini and Apollo entry guidance are reviewed. The point mass equations of motions are written in terms of vectors resolved in two noninertial coordinate systems, and approximate integrals of motion for various flight modes are formulated. Atmospheric models for entry performance and guidance studies are discussed. Supercircular and subcircular entry velocities are considered, and the factors involved in finalizing a guidance system are assessed. M.G.J.

N68-20002# RAND Corp., Santa Monica, Calif.
CONSIDERATIONS OF APPLYING CONTINUOUS THRUST DURING SYNERGETIC PLANE CHANGING
F. S. Nyland Dec. 1967 39 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5499-PR; AD-664884)

An investigation was made of the interactions of thrust and lift on equilibrium reentry trajectories to determine if the use of thrust during a turn will reduce the heat input to a winged spacecraft. In the maneuver considered in the study, propulsion is used shortly after the vehicle enters the atmosphere to cancel drag and provide additional lift, so that much of the heading change will occur during the cruise phase at constant vehicle velocity. Engine thrust is increased at the end of cruise to accelerate the vehicle into a new orbit, thus decreasing heating rates and vehicle temperatures. A variable-thrust engine is assumed. The study shows that by using propulsion during the turning phase of flight, the structural temperatures of lifting vehicles can be lowered by about 500 degrees F, compared with the temperatures encountered when the turn is made during a pure glide phase. If the turn is made at high velocity, fuel loss is minimized by using very large bank angles. No losses in vehicle performance were noted, and normal load factors were decreased. Author (TAB)

N68-20007 California Univ., Berkeley.
DEVELOPMENT OF A SATELLITE DRAG THEORY BASED ON THE VINTI FORMULATION
Thomas Joseph Sherrill (Ph.D. Thesis) 1966 187 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-5170

The methods of canonical transformations and variation of parameters are used to develop a theory of the motion of an artificial satellite under the combined effects of the earth's gravitational potential and atmospheric drag. The approach is essentially that of Brouwer and Hori except that the Vinti intermediary orbit is employed as a point of departure, rather than the Brouwer drag-free theory. The Vinti orbit, which is expressible in an extremely compact form, describes motion in a potential field which closely approximates the gravitational field of the oblate earth. A non-rotating oblate spheroidal model atmosphere is used, with an exponential variation of density with height above the earth's surface. The equations of motion are written in terms of certain modified Delaunay variables introduced by Izsak. Dissert. Abstr.

N68-20008*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SEMIANNUAL REVIEW OF RESEARCH AND ADVANCED DEVELOPMENT, VOLUME 1 Progress Report, 1 Jul.–31 Dec. 1967
31 Dec. 1967 467 p refs
(Contract NAS7-100)
(NASA-CR-93736; RAD-701-6, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22

Supporting research and technology for NASA's Office of Space Sciences and Applications is reviewed under the general categories of launch vehicle development, lunar and planetary explorations, physics and astronomy, and biosciences. Space chemistry, planetology studies, and planetary atmospheres and quarantine are being studied; and a wide variety of studies dealing with spacecraft and capsule equipment development are summarized. Other subject areas are spacecraft reliability, magnetodynamics in space, solar physics, and exobiology. M.W.R.

N68-20009 California Univ., Berkeley.
A FINE ANALYSIS OF α PERSEI AND β AQUARII
Sidney Bailey Parsons (Ph.D. Thesis) 1966 110 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-5137

The physical conditions in the atmospheres of two yellow supergiants (F5 and G0 Ib) are explored by applying line-blanketed non-gray convective model atmospheres to very high dispersion spectrograms. The models, which include microturbulent pressure in the total pressure, are iterated to nearly-constant flux by using the temperature-correction procedure of Mihalas (1965a). The method works well when the convective velocity is evaluated by numerical integration over one mixing length, but tends to be unstable when the usual localized expression is used. Effective temperatures of 6250±150°K and 5650±150°K are indicated for α Per and β Aqr from an analysis of absorption lines of several elements. Profiles of Hγ and Hδ, however, yield values of T_e about 300° higher in both cases. This discrepancy is not considered serious, especially since the computed profiles near the centers of the hydrogen lines are much shallower than the observed profiles. Dissert. Abstr.

N68-20010*# Adelphi Univ., Garden City, N. Y.
PHOTOGRAPHIC SEARCH FOR COMETS DURING 12 NOVEMBER 1966 SOLAR ECLIPSE Final Report
Henry C. Courten and Richard W. Genberg Mar. 1968 36 p
(Grant NGR-33-001-016)
(NASA-CR-93774) CFSTI: HC $3.00/MF $0.65 CSCL 03A

A ground-based photographic station was set up near Bagé in southern Brazil, which was at the centerline of a solar eclipse path on November 12, 1966, in order to search for small bright comets in the vicinity of the sun. The photographic plates indicated 10 extremely faint images, which were not identified with known stellar sources; and there were no cometary bodies brighter than sixth magnitude observed in the vicinity of the sun at the time of the eclipse. There was sufficient evidence, however, to support the original prediction for the existence of solar-proximate comets so that additional studies during the next total solar eclipse are warranted. M.W.R.

N68-20035*# Battelle Memorial Inst., Columbus, Ohio.
COMPARISON OF FUEL-OPTIMAL MANEUVERS USING A MINIMUM NUMBER OF IMPULSES WITH THOSE USING THE OPTIMAL NUMBER OF IMPULSES: A SURVEY
A. C. Robinson 12 Dec. 1967 83 p refs
(Contract NASw-1146)
(NASA-CR-93770; BMI-NLVP-TR-68-1) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Available data on the amount of fuel saved by using many impulses rather than the minimum number required to accomplish a maneuver are evaluated. Since multiple impulses are advantageous to some maneuvers and result in no fuel savings for other maneuvers, consideration is given to a number of different kinds of maneuvers. Coplanar and non-coplanar time-free transfers, coplanar and non-coplanar rendezvous and minimum-time transfers, and maneuvers involving neighboring orbits are discussed under two-body problems with a single attracting center; and the penalty due to finite thrust is noted. Maneuvers with two, three, and four attracting centers are also considered; and stochastic problems in orbit corrections using measurements are mentioned. M.W.R.

N68-20054*# Volt Technical Corp., Washington, D. C.
ON SOME MAGNETOHYDRODYNAMIC EFFECTS IN COMETS
Z. M. Ioffe 25 Mar. 1968 6 p refs Transl. into ENGLISH from Astron. Zh. (USSR), v. 44, no. 6, 1967 p 1304–1308
(Contract NAS5-12487)
(NASA-CR-93797; ST-COM-MHD-10694) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A general pattern of magnetic field-carrying solar wind flow past a comet is considered. Slamming of rays is explained by the velocity gradient in the flow behind the shock wave. The acceleration is found, which is imparted to plasma in the squeezing out process from the magnetic tubes of force (ray model). Its value is in accord with the observation data. It is shown that a narrow region of intensified magnetic field appears at the interface between the comet and the solar wind. Author

N68-20073*# IIT Research Inst., Chicago, Ill.
THERMOPHYSICAL ASPECTS AND FEASIBILITY OF A JUPITER ATMOSPHERIC ENTRY

J. E. Gilligan Jan. 1968 117 p refs
(Contract NASr-65(06))
(NASA-CR-93814; S-4) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A discussion of pertinent knowledge of Jupiter, the construction of a model atmosphere, and a very brief review of ballistics and general hypersonic heat transfer considerations lead to the development of a heat transfer prediction scheme based on stagnation point heating in hydrogen. A computer program is developed for calculating atmospheric entry, each of a variety of initial entry angles and velocities, atmosphere parameters, vehicle characteristics, ballistics, and thermodynamics over the entry trajectory. In particular, mass loss due to ablation is quite sensitive to initial entry velocity, which ranges from 48 to 60 km/sec, depending upon the advantage taken of Jupiter's very high rotation rate. An entry was designated "surviving" if, at the Jovian cloud tops (zero elevation), the vehicle had lost no more than 90% of its initial mass and had a velocity of less than 1 km/sec. With this context of survival, only posigrade, equatorial, grazing incidence entries will be relatively more successful than any others. Identified as major technological problem areas are planetary composition, thermophysical properties of high temperature gases, hypersonic heat transfer, and ablative materials performance. Author

N68-20074 California Inst. of Tech., Pasadena.
ROTATION AND MASSES OF GALAXIES AS DETERMINED BY SINGLE SPACING INTERFEROMETRY OF 21 CM HYDROGEN EMISSION
David Herbert Rogstad (Ph.D. Thesis) 1967. 123 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-6070

A total of 79 galaxies have been investigated with a two-element interferometer for content of neutral hydrogen. The baseline used was 100 feet east–west, and the filter bandwidth was 100 kHz. Thirty of the galaxies had detachable emission (>0.5 f.u.). The results are presented as line and position profiles for each galaxy (i.e., plots of the flux, and its position derived from the interferometer phase as a function of radial velocity). An extensive investigation of model profiles is also presented for the purposes of interpretation of the observed results. Using the estimated rotational parameters, total masses were calculated and are presented along with other quantities derivable from the profiles, such as the galaxy radial velocities and estimates of the neutral hydrogen masses. All of the irregular galaxies that were detected were found to be rotating, with the exception of WLM, which was inconclusive. Dissert. Abstr.

N68-20084*# North American Aviation, Inc., Downey, Calif.
GUIDANCE, FLIGHT MECHANICS AND TRAJECTORY OPTIMIZATION. VOLUME 7: THE PONTRYAGIN MAXIMUM PRINCIPLE
J. E. McIntyre Washington NASA Apr. 1968 129 p refs
(Contract NAS8-11495)
(NASA-CR-1006; SID-65-1200-7, V. 7) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Pertinent concepts from the maxima–minima theory are reviewed, and some of the concepts used in the calculus of variations are examined. The similarity between the Pontryagin maximum principle and the calculus of variations is discussed, and it is pointed out that both lead to the same set of governing equations which the extremizing solution must satisfy. However, the maximum principle is considered to be a clearer and more concise statement of how the optimization is to be conducted, particularly when certain types of inequality constraints are present. The maximum principle is used to formulate and solve a variety of problems encountered in optimal trajectory and control analysis. The treatment includes both linear and nonlinear systems, and problems with control inequalities and state inequalities. Several comparisons and parallels are drawn with both the calculus of variations and the maxima–minima theory of the differential calculus. Special problems and applications warrenting additional investigation are cited, such as the singular arc problem and the optimization of stochastic systems. M.G.J.

N68-20085*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THEORETICAL STUDY OF THE MAGNETIC FIELD IN THE LUNAR WAKE
Y. C. Whang Jan. 1968 29 p refs
(NASA-TM-X-63150; X-612-68-17) CFSTI: HC $3.00/MF $0.65 CSCL 03B

When the solar wind interacts with the moon, the plasma shadow region on the dark side of the moon forms a long lunar wake. In the plasma umbra a detectable plasma flow is absent; and in the penumbra the plasma flux increases from the void condition in the umbra to the interplanetary condition outside. A theoretical model for perturbations of the magnetic field in the plasma shadow is studied by directly solving Maxwell's equations for steady state solutions. The perturbation of the field is assumed to be due to the magnetization current, the gradient drift current and the curvature drift current. Numerical solutions are obtained to describe the variations of the magnetic field. The results obtained are in good agreement with experimental observations from the Explorer 35 satellite. Author

N68-20119*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
THE EFFECT OF 3-DIMENSIONAL NONLINEAR RESONANCES ON THE MOTION OF A PARTICLE NEAR THE EARTH–MOON EQUILATERAL LIBRATION POINTS
Hans B. Schechter May 1967 119 p refs
(Grant NsG-133-61)
(NASA-CR-93769; SUDAAR-316) CFSTI: HC $3.00/MF $0.65 CSCL 03C

In the uniformly rotating reference frame of the restricted 3-body problem the equilateral libration points L_4 and L_5 are known to be points of equilibrium. This dissertation presents the results of an analytic study of the 3-dimensional stability of motion of a particle near L_4 in a nonlinear Earth–Moon force field, upon which is superimposed a linear solar gravitational field distribution. The results show that in the presence of the internal nonlinearities the stability of motion predicted by the linear theory is valid for only a very restricted region of initial displacement and velocity disturbances. The inclusion of the external force terms was found to admit a stable equilibrium solution characterized by a coplanar elliptic particle orbit around L_4 which had its major axis (of magnitude roughly 120,000 mi) oriented at right angles to the line joining Earth to L_4. This orbit was traversed in a clockwise sense at mean angular rate equal to that of the Sun, as seen in the rotating coordinate frame, and very close to the particle's faster coplanar natural frequency. The particle's motion thereby became synchronized with that of the Sun. Author

N68-20127*# Volt Technical Corp., Washington, D. C.
DETERMINATION OF CHEMICAL COMPOSITION OF THE ATMOSPHERE OF VENUS BY THE INTERPLANETARY STATION "VENERA-4" [OPREDELENIYE KHIMICHESKOGO SOS TAVA ATMOSFERY VENERY MEZHPLANETNOY STANTSIYEY VENERA-4]
A. P. Vinogradov, Yu. A. Surkov, K. P. Florenskiy, and B. M. Andreychikov 9 Apr. 1968 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Ser. Astron. (Moscow), v. 179, no. 1, 1968 p 37–40
(Contract NAS5-12487)
(NASA-CR-93815; ST-LPS-ACH-10699) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The preliminary results of measurements on VENERA-4 of Venus atmosphere composition are as follows: CO_2: 90±10 percent; 0.4% < O_2 < 1.5%; N_2 < 7 percent; H_2O content is 1 to 8 mg 1. The contemporary atmospheres of the Earth and

Venus are compared and their various chemical reactions are discussed. It is concluded that endogenous processes are very close for both planets, while exogenous processes led to formation of quite different atmospheres. The deep rock erosion and surface leveling on Venus are explained by the heavy and "aggressive" atmosphere of the planet and its intense motion. Author

N68-20135 Georgetown Univ., Washington, D. C.
AN INVESTIGATION OF THE MAGNETIC AND RELATED STARS THROUGH PHOTOELECTRIC NARROW-BAND PHOTOMETRY
Robert Curry Cameron (Ph.D. Thesis) 1966 141 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-5218

Three hundred peculiar A stars (Ap stars), exhibiting enhanced spectral lines of certain elements, and 100 metallic-line A stars (Am stars), exhibiting general enhancement of the metallic spectrum, were observed photoelectrically with the 16-inch reflector of the Kitt Peak National Observatory. The great majority of the 93 known magnetic stars and 66 suspected magnetic stars (displaying Zeeman splitting of the spectral lines) are of the Ap or Am types, and are necessarily sharp-lined for detection of the Zeeman effect. The principal program stars included, in addition to the magnetic stars, Ap and Am stars with relatively broad spectral lines and also others which have never been examined for the Zeeman effect. Additional normal comparison stars and stars with unusual characteristics were observed also. The total number of stars observed was 749. Dissert. Abstr.

N68-20173# Royal Aircraft Establishment, Farnborough (England).
THE VARIATION IN THE ORBIT OF COSMOS 97 ROCKET THROUGHOUT ITS LIFE
H. Hiller Aug. 1967 13 p refs
(RAE-TR-67188; AD-665113)

Nearly two hundred acceptable observations were used with the R.A.E. orbit-improvement computer programme to determine the elements of the orbit of Cosmos 97 rocket (1965-95B) at fourteen nodal crossings distributed throughout its lifetime. The values of orbital inclination obtained were found to be accurate enough to give a satisfactory value for the rotational speed of the atmosphere. The accuracy of the observations has been assessed in terms of declination residuals and found to be often better than the observers own estimate. Author (TAB)

N68-20175*# Volt Technical Corp., Washington, D. C.
RESULTS OF THE EXPERIMENTS ON THE DETECTION OF LUNAR IONOSPHERE CONDUCTED ON THE FIRST ARTIFICIAL SATELLITE OF THE MOON [RESUL'TATY EKSPERIMENTOV PO OBNARUZHENIYU LUNNOY IONOSFERY PROVEDENNYKH NA PERVOM ISKUSSTVEN-NOM SPUTNIKE LUNY]
K. I. Gringauz, V. V. Bezrukikh, M. Z. Khokhlov, G. N. Zastenker, A. P. Remizov et al 1 Apr. 1968 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 170, no. 6, 1966 p 1306–1309
(Contract NAS5-12487)
(NASA-CR-93793; ST-LPS-LA-10695) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The experiments for the detection of lunar ionosphere, carried out on LUNA-10, were based upon the use of two traps for the respective registrations of low-energy positive ions and electrons. The results of observation of zones of increased concentration are discussed. The final results arrived at probably still are considerably overrated ($n_i \leq 100$ cm^{-3} and $n_e \leq 300$ cm^{-3}), which is due to side effects to be discussed in subsequent papers. Author

N68-20192*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
RELATIVISTIC MODELS OF THE UNIVERSE WITH PRESSURE EQUAL TO ZERO AND TIME-DEPENDENT UNIFORMITY
Windsor L. Sherman and Sylvia A. Wallace Washington Apr. 1968 42 p refs
(NASA-TR-R-282) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Previous work on the zero-density and approximate models of the universe is summarized. The zero-density model is improved so that it is a useful approximation of the exact model to greater values of the red shift, and regions of applicability of the approximate model are determined. Regions where closed-form solutions of the exact model exist, other than zero-density and zero-cosmical-constant models, are defined and the solutions are given. The results of calculations are presented that indicate, for the data considered, all the models, simplified and exact, appear to fit the data equally well even though there is wide variation in the density and acceleration parameters. In addition, the results of the calculations indicate that density and acceleration parameters should be determined as a pair from observational data. It is concluded that data consistent with that for galaxies at red shifts greater than one-half are required before a model universe can be selected and a simplified model defined. Author

N68-20285# Royal Aircraft Establishment, Farnborough (England).
PREDICTING SATELLITE VISIBILITY
Diana W. Scott Aug. 1967 27 p refs
(RAE-TR-67173)

A graphical method has been developed for predicting the latitudes from which a satellite in a circular orbit is visible, with the particular aim of discovering periods when a satellite may be observed in mid-latitudes in both the Northern and Southern Hemispheres. For near-polar orbits the occurrence of such periods depends critically on the position of the ascending node of the orbit; but for lower inclinations, the periods of visibility become shorter and more frequent, and the orientation of the orbit is less significant. Author

N68-20353*# Johns Hopkins Univ., Baltimore, Md.
INFRARED OBSERVATIONS OF THE OUTER SOLAR CORONA
Robert M. MacQueen Washington NASA Apr. 1968 54 p refs
(Grant NGR-21-001-044)
(NASA-CR-969) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The 2.2μ wavelength infrared outer solar corona was observed in two experiments: first, employing a ground-based telescope from a high altitude site near Pulacayo, Bolivia, during the 93 second totality of the eclipse of 12 November 1966; and second, employing a stratospheric balloon package with an infrared coronagraph, flown to an altitude of 28 km, during a 5.25 hour period, on 9 January 1967. The design and evaluation of the infrared balloon-borne coronagraph is discussed in detail, and the various origins of stray light investigated. The completed flight coronagraph was found to introduce a stray radiance of less than $3\times10^{-12}B_\odot$ where $B_\odot$ is the radiance of the mean solar disk at wavelength 2.2μ. During eclipse the corona was observed from $2R_\odot$ to $6R_\odot$ in the ecliptic plane, and at a single point perpendicular to the ecliptic at $5R_\odot$. Balloon observations covered the range $3.7R_\odot$ to $10R_\odot$ at position angles from 20° north to 40° south of the ecliptic, on the east limb of the sun. Author

N68-20358*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A FAST METHOD OF ORBIT COMPUTATION
Karl Stumpff and E. H. Weiss (IBM, Greenbelt, Md.) Washington Apr. 1968 41 p refs
(NASA-TN-D-4470) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The problem of rapidly computing trajectories of spacecrafts from their initial conditions has become very important. Classical methods rely almost exclusively on precise integration techniques, but results thus obtained are too slow over extended arcs, even on high-speed computers. Moreover, great accuracy is often unnecessary. Here we present a new method of computing approximate ephemerides of a small body (minor planet or artificial satellite). This method is 10 to 15 times faster than the well-known methods of Encke or Cowell. The errors are small (e.g., of the order of one part in a thousand) and the results converge to the N-body point-mass solution for small time steps. It is also possible to account for non-point-mass effects; this, however, has not yet been implemented. Author

N68-20358*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

CREW MOTION AND THE DYNAMIC ENVIRONMENT OF SPACEBORNE EXPERIMENTS

W. A. Beaudry, W. S. Clark, R. H. Grimes, M. A. Iannce, W. C. Middleton et al Jan. 1968 253 p refs

(Contract NAS8-21129)

(NASA-CR-61566; DAC-60963) CFSTI: $3.00 CSCL 22A

An analytic study of the effect of crew motion on the dynamic environment of orbiting laboratories was conducted. A computer program was used to determine the dynamic environment resulting from previously generated experimental data describing crew-motion force and moment histories. It is shown that the resulting acceleration histories exceed the requirements of nearly all the proposed low-acceleration propellant experiments, and the attitude histories exceed the requirements of a substantial but small portion of the pointing experiments. A number of methods are suggested for improving the design of the laboratories to minimize crew motions. Five passive systems were investigated for minimizing the force transmitted to the vehicle. Two of the systems show sufficient promise to recommend further study. The analyses included indicate that these two devices could reduce the attitude error to within the requirements of all pointing experiments surveyed and substantially increase the number of propellant experiments possible (although a majority of the propellant experiments surveyed would still be unfeasible). Author

N68-20367# Royal Aircraft Establishment, Farnborough (England).

ON THE USE OF RANGE AND RANGE RATE MEASUREMENTS IN THE NEW R.A.E. ORBIT DETERMINATION PROGRAM

R. H. Gooding Jul. 1967 10 p refs Presented at the COSPAR Intern. Space Sci. Symp., London, Jul. 1967

(RAE-TR-67199) CFSTI: HC $3.00/MF $0.65

The new orbit determination program PROP can use range and range rate observations as well as observations of direction. The orbit of OGO 2 (1965-81A) has been determined at epoch 1965 November 10.0, using Minitrack observations and Goddard range and range rate observations. The results show reasonable agreement between observations from the two systems and suggest that random errors in the range and range rate observations are of the order claimed. Author (ESRO)

N68-20368*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYTICAL CALCULATION OF PARTIAL DERIVATIVES RELATING LUNAR AND PLANETARY MIDCOURSE CORRECTION REQUIREMENTS TO GUIDANCE SYSTEM INJECTION ERRORS

Fred Teren and Gary L. Cole Washington Apr. 1968 39 p refs

(NASA-TN-D-4518) CFSTI: HC $3.00/MF $0.65 CSCL 22C

This report describes a simplified analytical method for calculating partial derivatives relating midcourse correction velocity requirements to injection errors resulting from guidance system errors for lunar and planetary missions. The analytical method uses two-body equations of motion to describe the reference transfer orbit. These equations are linearized to obtain partial derivatives relating changes in terminal state conditions to changes at injection and midcourse. The partial derivatives are then used to calculate the required correction velocity. The analytical equations are easily programmed on a digital computer and require very little computer time. The only input variables required are the position and velocity components at injection from a reference trajectory. The analytical partial derivatives are compared to exact partial derivatives obtained from a detailed N Body computer simulation. A comparison of results is presented for two lunar and five planetary missions. The error in the approximate results is found to be less than 14 percent for all cases simulated. Author

N68-20376# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.

SPACE RESEARCH. DIRECTIONS FOR THE FUTURE

1966 654 p refs

(NAS-NRC-1403) Available from Printing and Publishing Office, Natl. Acad. of Sci., Washington, D. C.: $7.50

CONTENTS:

1. PLANETARY AND LUNAR EXPLORATION p 3-144 refs (See N68-20377 10-30)

2. OPTICAL ASTRONOMY p 147-175 refs (See N68-20378 10-30)

3. SOLAR ASTRONOMY p 177-237 (See N68-20379 10-30)

4. RADIO AND RADAR ASTRONOMY p 239-267 (See N68-20380 10-30)

5. X-RAY AND GAMMA-RAY ASTRONOMY p 269-314 (See N68-20381 10-30)

6. PHYSICS AND GEOPHYSICS p 315-338 refs (See N68-20382 10-13)

7. ROCKET-SATELLITE RESEARCH p 341-444 refs (See N68-20383 10-30)

8. SPACE RESEARCH AND THE UNIVERSITY p 445-475 refs (See N68-20384 10-30)

9. BIOLOGY p 477-500 refs (See N68-20385 10-04)

10. MEDICINE AND PHYSIOLOGY p 501-621 refs (See N68-20386 10-04)

11. ROLE OF MAN IN SPACE RESEARCH p 623-637 ref (See N68-20387 10-30)

N68-20377# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.

PLANETARY AND LUNAR EXPLORATION

In its Space Res. Direc. for the Future 1966 p 3-144 refs (See N68-20376 10-30)

Various approaches to gathering data on the solar system are analyzed as a basis for examining the problems of exploring the solar system, and of assigning priorities determined by current scientific interest and their relevance to the questions of the origin of the solar system, the origin of life, and the understanding of the earth. Lunar and planetary exploration priorities are listed in order of rank as Mars, the Moon and Venus, major planets, comets and asteroids, Mercury, Pluto, and interplanetary dust. The strategy of such explorations, and the manpower and facilities required, are assessed. Major scientific questions relating to the members of the solar system are defined, and major recommendations on techniques for answering these questions are presented. Consideration is also given to the limitations of information transfer over interplanetary distances. M.G.J.

N68-20378# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.

OPTICAL ASTRONOMY

In its Space Res. Direc. for the Future 1966 p 147–175 refs (See N68-20376 10-30)

The important research objectives of astronomy in general, and of optical astronomy in space in particular, are discussed. Consideration is given to the possibilities for studying stars, star systems, nebulae, and planets by means of telescopes in space sensitive to electromagnetic radiation at wavelengths between 800 Å and 1 mm. Recommendations for the 1965–1975 program include (1) doubling the number of coarse-pointing sounding rockets available for optical space astronomy; (2) the inclusion of two or more telescopes with apertures of 40 in. or more in the Apollo Extension Systems program; and (3) developing improved gratings and optical interferometers. For the after-1975 program, it was urged that research efforts should be focused on developing a very large orbital telescope to be used with a wide variety of astronomical instrumentation. It is concluded that a space telescope with a resolution corresponding to an aperture of at least 120 in., detecting radiation between 800 Å and 1 mm and requiring the capability of man in space, is technically feasible. M.G.J.

N68-20379# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
SOLAR ASTRONOMY
In its Space Res. Direc. for the Future 1966 p 177–237 (See N68-20376 10-30)

The interrelationship of solar astronomy and solar space astronomy is delineated, and an assessment is made of the contributions that solar astronomy makes to such fields as stellar and radio astronometry, planetary atmospheres, interstellar matter, biology, atomic physics, and meteorology, along with its influence on terrestrial radio communication and astronaut safety. Major current and projected NASA programs in solar physics are critically reviewed. Problems, instruments (including the role of man), and vehicles were considered according to spectral regions: $\lambda < 500$ Å, $500 < \lambda < 1500$ Å, $1500 < \lambda < 3000$ Å, and $\lambda > 3000$ Å. The resulting recommendations are examined in detail. Also discussed are the use of rockets, the role of man, the relation of the astronaut-observer to the scientist directing the experiment, the role of the ground-based laboratory in the space effort, and the question of a moon-based observatory. M.G.J.

N68-20380# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
RADIO AND RADAR ASTRONOMY
In its Space Res. Direc. for the Future 1966 p 239–267 (See N68-20376 10-30)

Plans for developing radio and radar astronomy in space are reviewed, and the major instrumental and observational advances which should occur by 1980 are outlined. Three aspects are examined: long-wave radio astronomy where observations are made in the frequency range from 10 MHz to a few hundred kHz; millimeter and long wave infrared astronomy in which the wavelength range is taken to be from 10 mm wavelength (30 GHz) to a few tens of microns; and radar astronomy, wherein most observations fall in the range between about 6 meters (50 MHz) and centimeter wavelengths. Specific recommendations include: (1) Studies should be initiated on possible concepts for a space radio telescope with an aperture on the order of 20 km, which appears to be close in size to the ultimate for observing observations between a few MHz and a few hundred kHz. (2) Work should be started on a high resolution, broadband antenna system for radio astronomical observations over the frequency range 10 MHz to a few hundred kHz. Also discussed are techniques and specific questions involving man in space and moon-based experiments. M.G.J.

N68-20381# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
X-RAY AND GAMMA-RAY ASTRONOMY
In its Space Res. Direc. for the Future 1966 p 269–314 (See N68-20376 10-30)

The potentials of X-ray and gamma-ray astronomy are forecast as providing tools for probing fundamental cosmological problems, including the origin of cosmic rays; the density of cosmic rays in galaxies and in the universe; the strength of galactic and intergalactic magnetic fields; the hypothesis of continuous creation of matter; and the temperature, density, and composition of galactic and intergalactic matter. Theories on the production of cosmic X-radiation and gamma-radiation are discussed in the context of the role these production mechanisms play in planning future experiments and in designing instruments for observations. Vehicle requirements are defined for balloons, rockets, and satellites, and the design and construction of a prototype universal supernova monitor for inclusion on future spacecraft is recommended. Several aspects of using man in making X-ray and gamma-ray observations in space are considered. M.G.J.

N68-20383# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
ROCKET-SATELLITE RESEARCH
In its Space Res. Direc. for the Future 1966 p 341–444 refs (See N68-20376 10-30)

The opportunities that can best be met by the exploitation of sounding rockets, either alone or in combination with other means of measurement, are reviewed under four scientific discipline categories—the neutral atmosphere, the ionized atmosphere, the magnetosphere, and astronomy. It is shown that rockets have a clear advantage in vertical soundings; satellites appear to have the advantage in mapping large volumes of the atmosphere above 200 km and in obtaining climatological data. Several kinds of experiments are discussed for which the optimum plan is to employ rocket soundings coordinated with satellite passes over launching ranges. Rocket and satellite vehicles, and auxiliary systems, are described, and cost data are included. Research recommendations and manpower requirements are presented. M.G.J.

N68-20384# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
SPACE RESEARCH AND THE UNIVERSITY
In its Space Res. Direc. for the Future 1966 p 445–475 refs (See N68-20376 10-30)

The NASA Sustaining University Program is discussed in terms of the overall question of mutual understanding of functions, the desirability of uniform application of NASA Headquarters policies, grants versus contracts, overhead, the growing complexity of flight experiments, short-range versus long-range research problems, and the relationships of the nature and level of in-house research with that carried out under grants and contracts. Consideration is also given to NASA–university relations and to the major problems relating to university participation in flight programs. Funding data are provided, and the participating universities are listed. M.G.J.

N68-20387# National Academy of Sciences—National Research Council, Washington, D. C. Space Science Board.
ROLE OF MAN IN SPACE RESEARCH
In its Space Res. Direc. for the Future 1966 p 623–637 ref (See N68-20376 10-30)

The limitations and advantages of man as an experimenter in space are discussed in terms of the nature of the role to be played, the relationship of manned and unmanned space research, and the selection and training of flight personnel. Also discussed are the scientific experiments designed for the Gemini and Apollo programs, and the scientific importance of large manned orbital laboratories capable of long-duration flights. Four types of programs using man for scientific studies in space are visualized: (1) the Gemini and Apollo programs, which can carry modest scientific experiments to be performed by the astronauts, but where scientific

objectives are secondary to engineering and human survival; (2) later manned orbiting laboratory flights, where an important objective of the mission is to carry out relatively demanding scientific measurements and observations; (3) large, complex, special-purpose space assemblies, such as optical or radio-astronomical observatories that are designed specifically to be assembled, aligned, serviced, or operated by men in space; and (4) scientific operations on lunar or planetary surfaces. M.G.J.

N68-20401# Contraves Corp., Zurich (Switzerland).
SATELLITE TEMPERATURE AS A FUNCTION OF ECLIPSE TIME
H. Eder [1967] 24 p refs
CFSTI: HC $3.00/MF $0.65

In the temperature behavior of satellites, the end-temperature after 5000–10,000 orbits and the temperature gradient entering the orbit are of interest. In former calculations a node-equation system was used and the temperature for 10–20 orbits numerically calculated. Extrapolations based on numerical results or on tests give only very rough predictions of the end-temperature of satellites. In this paper an analytic solution for the end-temperature is derived for any form of input function. The ecliptic case is given special consideration. Formulae are given for the end-temperature as a function of ecliptic time. The temperature gradient is calculated for the launch in the sun and shadow part of the orbit. As an example, the thermal behavior of ESRO 1 satellite is treated. Author (ESRO)

N68-20415# National Aero- and Astronautical Research Inst., Amsterdam (Netherlands).
ELDO FUTURE PROGRAMS: STUDY OF PERTURBATIONS OF CERTAIN ORBITS FOR TELECOMMUNICATION SATELLITES
C. R. Traas 31 Jul. 1964 30 p refs Prepared for ELDO
(NLR-G-35) CFSTI: HC $3.00/MF $0.65

A study is made of the perturbations of certain orbits, suitable for communication satellites, e.g. the 24- and 12-hour equatorial orbits and the 8- and 6-hour polar orbits. A survey of the results available in the literature is given. In addition a number of detailed numerical results are discussed. The amount of corrective impulses needed per year for station keeping is indicated. Author (ESRO)

N68-20434* Earth Science Research Corp., Santa Monica, Calif.
STUDY OF SHAPE AND INTERNAL STRUCTURE OF MOON, UTILIZING LUNAR ORBITER DATA Quarterly Progress Report
Donald L. Lamar and J. V. Mc Gann-Lamar Mar. 1968 26 p refs
(Contract NSR-05-264-002)
(NASA-CR-93820; QPR-7) CSCL 03B

A preliminary tabulation of circular basins observed on the moon is presented, and a map of the distribution of lunar mares and circular basins is being prepared. Computer programs using a spherical harmonics expansion are included to determine these distributions as well as the orientation of their principal axes. Author

N68-20436# Royal Aircraft Establishment, Farnborough (England).
FURTHER STUDIES OF THE LIFETIMES OF SATELLITES IN LARGE-ECCENTRICITY ORBITS
G. E. Cook and Diana W. Scott Aug. 1967 16 p refs Submitted for publication Suppl. to RAE-TR-65292
(RAE-TR-67189; RAE-TR-65292) CFSTI: HC $3.00/MF $0.65

Lifetime estimates have been made for three satellites in the Molniya series launched since the beginning of 1966, and the decay of Molniya 1B in March 1966 has confirmed our earlier estimate of its lifetime. This Report supplements an earlier paper in which the lifetimes of 8 satellites were predicted, and a combined version is to be published in Planetary and Space Science. Author (ESRO)

N68-20449*# North American Aviation, Inc., Downey, Calif.
GUIDANCE, FLIGHT MECHANICS AND TRAJECTORY OPTIMIZATION. VOLUME 8: BOOST GUIDANCE EQUATIONS
G. E. Townsend, A. S. Abbott, and R. R. Palmer Washington NASA Apr. 1968 134 p refs
(Contract NAS8-11495)
(NASA-CR-1007; SID-65-1200-8) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Near optimum steering equations were developed for boost vehicles, with the constraint that solutions must be possible in less than real time on the small digital computer used in the guidance system of boost vehicles. Approaches discussed are path adaptive or iterative guidance, explicit guidance employing guidance polynomials, and perturbation guidance. The iterative and perturbation guidance approaches have been or are currently being applied to boost vehicles, and detailed equations are presented in both cases. Because of numerical problems implicit in the preflight simulation and construction of the coefficients of the polynomial, the third approach is not being considered for application. M.W.R.

N68-20450*# North American Aviation, Inc., Downey, Calif.
GUIDANCE, FLIGHT MECHANICS AND TRAJECTORY OPTIMIZATION. VOLUME 9: GENERAL PERTURBATIONS THEORY
B. Kampos Washington NASA Apr. 1968 205 p refs
(Contract NAS8-11495)
(NASA-CR-1008; SID-66-1678-1) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Solutions obtained by general perturbations techniques were studied for applications to mission analysis and inflight phases of space programs. Data on oblateness, atmospheric drag, extraterrestrial gravitation, and solar radiation pressure perturbations are reviewed; and detailed analyses are presented for some of these. Dominant perturbations for most earth satellites are discussed in terms of the earth's oblateness; and development of the atmospheric perturbation and satellite motion is considered. A scheme for approximating the net result of all these perturbating influences is presented, along with a mechanization to effect the solution that is based on the optimum formulations of each phase of the analysis. M.W.R.

N68-20468*# North American Aviation, Inc., Downey, Calif.
GUIDANCE, FLIGHT MECHANICS AND TRAJECTORY OPTIMIZATION. VOLUME 16: MISSION CONSTRAINTS AND TRAJECTORY INTERFACES
R. L. Robertson Washington NASA Apr. 1968 128 p refs
(Contract NAS8-11495)
(NASA-CR-1015; SID-66-1678-8, V. 16) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Launch, rendezvous, spatial, deorbit, and entry trajectory phases are considered for earth orbital missions in order to formulate the more important constraints required for a realistic mission. Details are considered for the launch window, range safety, and ascent trajectories during boost and for direct ascent, rendezvous compatible orbits, intermediate orbit rendezvous techniques, and terminal maneuver during rendezvous. Perturbation and lifetime, earth trace and coverage, lighting and eclipse geometry, and radiation aspects of the rendezvous trajectory are noted. The general deorbit maneuver is discussed, as is minimum energy/time deorbit, deorbit timing, and deorbit via intermediate orbit. Entry dynamics and entry heating are noted; and direct entry, lifting entry and equilibrium glide path, and maneuverability are considered. Recommended procedures are mentioned in light of the discussion on mission constraints and their relationship to trajectories. M.W.R.

N68-20485# Royal Aircraft Establishment, Farnborough (England).
SATELLITE RESONANCE WITH LONGITUDE-DEPENDENT GRAVITY. 2: EFFECTS INVOLVING THE ECCENTRICITY
R. R. Allan Aug. 1967 32 p refs Presented at the COSPAR Symp., London, Jul. 1967
(RAE-TR-67172) CFSTI: HC $3.00/MF $0.65

For a satellite in a nominally circular orbit at arbitrary inclination whose mean motion is commensurable with the Earth's rotation, the dependence of gravity on longitude leads to a resonant variation in eccentricity as well as the long-period oscillation in longitude. Provided forces capable of precessing perigee are present, it is shown that the change in eccentricity for a satellite captured in librational resonance is not secular but periodic. There are corresponding resonance effects for a satellite in a nominally equatorial but eccentric orbit. Here the commensurability condition is that the longitudes of the aspes shall be nearly repetitive relative to the rotating Earth. There will be a long-period oscillation in longitude which can take the form of either a libration (trapped) or a circulation (free), and there will also be an oscillation of the orbital plane having the same period as the precession of perigee relative to inertial space. Author (ESRO)

N68-20530 Joint Publications Research Service, Washington, D. C.
ASTRONOMY
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 177 3 Apr. 1968 p 1–6 refs (See N68-20529 10-13)

Abstracts are presented on scientific articles pertaining to (1) the possibility of evolution of a superdense star, using a simplified Fermi gas model; (2) an approximate method of solving the problem of radiation diffusion for the case of strongly elongated scattering index; (3) computer construction of growth curves; (4) oxygen absorption lines in the Venusian atmosphere; (5) an electronic device for simultaneously recording all magnetic field components; (6) ionospheric disturbances associated with proton and nonproton flares; (7) sources of noise storms relative to optical features on the solar disk; (8) radio emission of extra-limb flares; and (9) growth curves for solar flares. News items are included on the instrumentation and operational aspects of the Kourovskaya Astronomical Observatory of Ural State University; astronomical orientation on the moon; and the construction of a large tower for the Byurakan Astrophysical Observatory. M.G.J.

N68-20535 Ohio State Univ., Columbus.
A HIGH SENSITIVITY STUDY OF THE GALACTIC NORTH POLAR REGION AT 1415 MHZ
Donald Jordan Scheer (Ph.D. Thesis) 1966 266 p
Available from Univ. Microfilms: HC $12.15 MF $3.45 Order No. 67-6367

A continuum survey of the galactic north polar region has been conducted at 1415 MHz using the Ohio State University 260-ft radio telescope with a liquid-nitrogen refrigerated parametric preamplifier. The survey covers approximately 975 deg^2 of sky (8100 beam areas) and includes most of the area between right ascensions 08^h00^m and 16^h00^m and declinations 25°00'N and 37°40'N. The principal endeavors have been compilation of the radio source catalog, plotting the segmented contour maps, and determination of results having astronomical significance. Measured positions and flux densities of 330 discrete radio sources having flux density $S \geq 0.3$ flux unit (1 flux unit = 1 fu = 10^{-26} watt m^{-2} Hz^{-1}) at 1415 MHz have been tabulated. This number of sources gives a sky source density of about 3 deg^2 per source. It is estimated that less than 10% of these sources are galactic, approximately 55% are radio galaxies and about 24% are quasi-stellar radio sources. Dissert. Abstr.

N68-20546# School of Aerospace Medicine, Brooks AFB, Tex.
PROGRESS IN UNMANNED SPACE EXPLORATION
William H. Pickering *In its* Lectures in Aerospace Med., 6th Ser. 1967 p 1–27 (See N68-20545 10-04)

The scientific exploration of space utilizes long range radio telemetry systems to transmit measurements and command signals from and to earth. This makes it possible to use spacecraft for meteorological observations, to agitate and direct robot machines on planetary surfaces as well as to provide precision guidance to the Moon and planets for unmanned space probes. Several example designs included depict Surveyor spacecraft and Mariner spacecrafts and their payload concepts. G.G.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N68-19612*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-49, VOLUME 1 FOR THE PERIOD NOVEMBER 1 TO DECEMBER 31, 1967. FLIGHT PROJECTS
31 Jan. 1968 98 p refs
(Contract NAS7-100)
(NASA-CR-93680; JPL-SPS-37-49, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

CONTENTS:

1. PLANETARY–INTERPLANETARY PROGRAM p 1–30 ref (See N68-19613 10-31)
2. LUNAR PROGRAM p 31–64 (See N68-19614 10-31)
3. ADVANCED STUDIES p 65–85 (See N68-19615 10-30)

N68-19613*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY–INTERPLANETARY PROGRAM
In its Space Programs Sum. No. 37-49, Vol. 1 for the Period Nov. 1 to Dec. 31, 1967. Flight Proj. 31 Jan. 1968 p 1–30 ref (See N68-19612 10-31)

Summary data are presented on the Mariner 4 project. Guidance and control instrumentation for the Mariner Venus 67 project are described along with operational support equipment changes from earlier Mariner spacecraft. The scientific experiments conducted during the mission are tabulated. Launch vehicle integration and spacecraft system design for the Mariner Mars 1969 project are discussed, and the six planetary science experiments that have been selected are presented in tabular form. Near earth mission design criteria are given in terms of near earth tracking data system coverage capabilities and limitations. The test complex data system and automatic function checkout system are described. Power subsystems for the guidance and control of the spacecraft are examined. Prototype units and breadboard models of the data automation system are depicted and data processing techniques discussed. The propulsion system configuration is shown and the prequalification test program for the engines is outlined. Mechanical drawings and circuit diagrams of the pyrotechnic control subsystem are included. E.J.S.

N68-19614*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LUNAR PROGRAM
In its Space Programs Sum. No. 37-49, Vol. 1 for the Period Nov. 1 to Dec. 31, 1967. Flight Proj. 31 Jan. 1968 p 31–64 (See N68-19612 10-31)

Introductory data are presented on the Surveyor project and the engineering aspects of Surveyor structures, mechanisms, and

spacecraft integration are briefly discussed. The main retroengine and the vernier propulsion system are described, and failure mechanisms with the helium pressure regulator and the Vitron-A O ring in the oxidizer tank are examined. The helium pressure regulator failed during the SC-5 flight, and the O ring failed 7 days after Surveyor 5 landed on the lunar surface. Thermal performance data are tabulated for SC-7. Mission E second lunar day, and mission F operations of the Deep Space Network are briefly described. E.J.S.

N68-19652# Library of Congress, Washington, D. C. Aerospace Technology Div.
KOSMOS SATELLITES, 1967
Daniel W. Michaels *In its* Foreign Sci. Bull., Vol. 4, No. 3 Mar. 1968 p 16–23 refs (See N68-19649 10-34)

On the basis of analysis of the orbital elements of Cosmos satellites, an attempt is made to classify Cosmos vehicles according to probable mission. Several new Cosmos types are identified. Author

N68-19837*# Boeing Co., Seattle, Wash. Space Div.
INTEGRATED MANNED INTERPLANETARY SPACECRAFT CONCEPT DEFINITION. VOLUME 5: PROGRAM PLANS AND COSTS Final Report
Jan. 1968 296 p
(Contract NAS1-6774)
(NASA-CR-66563; D2-113544-5) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Program plans and costs for the recommended interplanetary mission system include the program planning and cost conditions, the program schedules, the test program, the facilities plan, and program costs and funding. The first two reasonable missions are a 1983 Venus Short Mission, followed by a 1986 Mars Opposition Mission. Total program costs, including the two missions, are approximately $29 billion with the peak funding rate of $3.4 billion per year occurring in the 1976–1978 time period. Test plans are from early design development tests through qualification and end with a complete system flight demonstration in Earth orbit. Launch Complex 39 at Kennedy Space Center is used with modifications and additions. Author

N68-20025 Catholic Univ. of America, Washington, D. C.
ON THE MOTION AND STABILITY OF A MULTIPLE CONNECTED GRAVITY-GRADIENT SATELLITE WITH PASSIVE DAMPING
Peter Montgomery Bainum (Ph.D. Thesis) 1966 146 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-7494

A generalized analytical method is formulated for studying the motion and stability of a gravity gradient satellite inertially connected with one or two gimballed damping booms which are assumed to be hinged at or very near the system center of mass; it is the relative motion between these connected bodies which affords a means of dissipating the librational energy. The equations of rotational motion are derived using Lagrange's general formulation, where the system center of mass is assumed to be in a circular orbit. Included are the effects of the gravitational restoring torques, the dissipative torques, and the gyroscopic torques that result from the coupling between the orbital angular velocity and the rotational motion in pitch-roll–yaw referenced to a local vertical frame. Expressions are developed for the thermal deflections of the extendible booms and the torques resulting from the interaction of solar radiation forces with the bent booms. Dissert. Abstr.

N68-20046*# Boeing Co., Huntsville, Ala.
STUDY OF ADVANCED MULTIPURPOSE LARGE LAUNCH VEHICLES Summary Report
Jan. 1968 31 p
(Contract NAS2-4079)
(NASA-CR-73154) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Study results are summarized for a conceptual design analysis of "Advanced Multipurpose Large Launch Vehicles." This vehicle concept incorporates a single-stage-to-orbit main stage that orbits a million pound payload; and, with the addition of building block elements that include strap-on motors and a small injection stage, provides payload flexibility to nearly four million pounds. The objective of the study was to develop practical, representative vehicle configurations through a series of design and performance trade studies, and to assess this vehicle system in terms of technology needs and implications. A vehicle family is provided with its estimated performance for each of its possible flight configurations. The design and performance data developed in trade studies of design variables investigated in reaching the representative configuration are summarized. Author

N68-20198*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STRESSES CAUSED BY AN IN PLANE LINE LOAD USED TO ROTATE A THIN-WALLED SPHERICAL SATELLITE
W. Jefferson Stroud and Nancy P. Sykes Washington Apr. 1968 36 p refs
(NASA-TN-D-4425) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The stress resultants and deformations which are brought about by a sinusoidal in-plane line load acting along a great circle of a spherical satellite of the Echo type are calculated and are presented in contour plots and in tabular form. The line load is applied in order to rotate the thin-walled spherical satellite for station-keeping purposes. The line load is induced by the interaction of a current-carrying wire with the geomagnetic field. Linear membrane theory and numerical methods are used in the analysis. Author

N68-20224# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
A STUDY OF THE EFFECT OF SLOPING GROUND ON BEARING STRENGTH AND THE LANDING PERFORMANCE OF SPACE VEHICLES
Leslie L. Karafiath and Edward A. Nowatz Mar. 1968 70 p refs
(RM-407)

A theory is developed for the evaluation of the static bearing capacity of a sloping surface acted upon by vertical or inclined loads. It is shown that, all other things being equal, the bearing strength of a sloping surface acted upon by vertical loads is less than that of a horizontal surface. Application of this theory to the landings of Surveyors 1 and 5 explains the apparent discrepancy in bearing strength by the effect of the slope very well. The footpad data from Surveyors 1 and 5 and the data obtained from bearing tests performed by the Soil Mechanics Surface Sampler (SMSS) experiment of Surveyor 3 indicate that the soil strength parameters at the three Surveyor sites are remarkably uniform. With this as a basis, estimates are made of the static resistance of the lunar surface material to the LM footpad for various surface slope angles and load inclinations. Charts are presented for the bearing capacity factors and factor reduction coefficients as a function of friction angle for inclined strip loads on a slope. Author

N68-20228# Laboratoire de Recherches Balistiques et Aerodynamiques, Vernon (France).
PRINCIPLE CHARACTERISTICS AND PERFORMANCES OF DIFFERENT LAUNCHERS UTILIZABLE FOR QUALIFICATION TESTS OF SPACEBORNE EQUIPMENT [CARADTERISTIQUES PRINCIPALES ET PERFORMANCES DE DIVERS LANCEURS UTILISABLES POUR LA QUALIFICATION SPATIALE D'EQUIPEMENTS]

C. Marechal 11 Jan. 1968 28 p In FRENCH
(NT-9/68/EN) CFSTI: HC$3.00/MF$0.65

This is a presentation of tables of technical characteristics and performance curves showing the possibilities offered by some French sounding rockets and launch vehicles to test spaceborne equipment. ESRO

N68-20271# Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.
KINETHEODOLITE OBSERVATIONS MADE AT EARLYBURN, JANUARY 1965 TO MARCH 1966: SATELLITE 1964-53 A
Bennet McInnes 5 Feb. 1968 20 p refs
(ROE-STS-67) CFSTI: HC$3.00/MF$0.65

Observations made with the Earlyburn cinetheodolite are given in fully reduced form for fifteen transits of satellite 1964-53 A (called Cosmos 44). Author (ESRO)

N68-20290*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 2: LAUNCH VEHICLES
Arthur Zimmerman Washington 1968 17 p Presented at the Lewis Aerospace Explorers Conf., Cleveland, 1966–1967
(NASA-TM-X-52398) CFSTI: HC$3.00/MF$0.65 CSCL 22D

In order to understand the specific features of a launch vehicle, the general characteristics and some of the factors that determine their performance are discussed. A typical two-stage launch vehicle is briefly evaluated, and the major systems of the second stage are described. These include structure and tankage, propulsion and plumbing, guidance, control, pressurization, flight instrumentation, electrical systems, residuals, and payload adapter. A typical launch trajectory is given, and the equation for determining circular velocity is derived. The equation for the burnout velocity of a vehicle is also presented, and its application in determining the performance of a vehicle is shown. The seven launch vehicles in current use are listed along with the characteristics of each. B.S.D.

N68-20299# Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.
KINETHEOLOLITE OBSERVATIONS MADE AT EARLYBURN, APRIL TO JUNE 1965: SATELLITE 1961 ALPHA 1
Bennet McInnes 16 Feb. 1968 8 p refs
(ROE-STS-70) CFSTI: HC$3.00/MF$0.65

Observations made with the Earlyburn cinetheodolite are given in fully reduced form for three transits of satellite 1961 alpha 1. Author (ESRO)

N68-20306# Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.
KINETHEODOLITE OBSERVATIONS MADE AT EARLYBURN, OCTOBER 1964 TO MARCH 1966: SATELLITE 1960 GAMMA 2
Bennet McInnes 9 Feb. 1968 12 p refs
(ROE-STS-69) CFSTI: HC$3.00/MF$0.65

Observations made with the Earlyburn cinetheodolite are given in fully reduced form for seven transits of satellite 1960 gamma 2 (usually called Transit 1B). Author (ESRO)

N68-20308# Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.
STOPWATCH OBSERVATIONS OF SATELLITES, NOVEMBER 1967
R. D. Eberst 7 Feb. 1968 21 p refs
(ROE-STS-68) CFSTI: HC$3.00/MF$0.65

Stopwatch observations made at stations connected with the Section during November 1967 are listed in satellite launch order and in time order for each satellite. Various sub-totals are given. Author (ESRO)

N68-20413*# Chrysler Corp., New Orleans, La. Space Div.
AAP-1A LAUNCH VEHICLE PERFORMANCE AND PRELIMINARY RANGE SAFETY ANALYSES. VOLUME 2: RANGE SAFETY
J. M. Bartholomew Nov. 1967 37 p refs
(Contract NAS8-4016)
(NASA-CR-93656; SSR-107; TN-AP-67-279) CFSTI: HC $3.00/MF$0.65 CSCL 22D

This volume presents range safety data and results for an uprated Saturn IB (AS-207/CSM) configuration into an 87×140 n. mi. elliptical orbit and is related to the AAP-1A mission. Eight nominal trajectories were developed for this study—a northeast launch and a southeast launch for each of four orbit inclinations. The in-plane length of S-IB stage impact containment zones related to both northeast and southeast trajectories varies between 44.3 km and 47.5 km. The in-plane length of ullage-rocket cases impact containment zones varies between 58.1 km and 63.2 km. Since land masses are overflown, an impact and casualty probability study was conducted. Dwell times for the continental land masses overflown vary from 6.76 to 8.68 seconds for the northeast launches and from 0.37 to 93.28 seconds for the southeast launches. Author

N68-20437# Laboratoire de Recherches Balistiques et Aerodynamiques, Vernon (France).
POSITION KEEPING AND THREE AXIAL CONTROL OF A TELECOMMUNICATION SATELLITE [MAINTIEN A POSTE ET PILOTAGE TROIS AXES D'UN SATELLITE DE TELECOMMUNICATIONS]
C. Marechal 17 Jan. 1968 78 p refs In FRENCH
(NT-10/68/EN) CFSTI: HC$3.00/MF$0.65

It is shown that a stationary satellite with three axial control over the Atlantic Ocean is feasible. Its main advantages are mentioned and the order of magnitude of the necessary longitude and latitude corrections are evaluated. The attitude control system, an inertial flywheel and a hydrazine engine are discussed. ESRO

N68-20467*# General Dynamics Corp., San Diego, Calif.
EVALUATION OF THE EFFECTS OF SPACE ENVIRONMENT EXPOSURE ON INDEX OF REFRACTION AND EXTINCTION COEFFICIENTS OF APOLLO WINDOW MATERIALS
J. T. Neu, E. J. Philbin, P. Mahadevan, and J. Compton Washington NASA Apr. 1968 112 p refs
(Contract NAS9-4948)
(NASA-CR-1019; GDC-DBE-67-001) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Temperature and radiation effects were studied on fused silica, Vycor, and aluminosilicate glass used for Apollo windows. Transmittance and index of refraction were measured as a function of wavelength at room and elevated temperatures prior to irradiation with a dosage that simulated a 30-day Apollo mission. Transmittance measurements were repeated following this exposure, and additional measurements were made with a 3-day dose equivalent and also a 0.3-day dose. For the last, no change in transmittance was observed for any of the materials. For the prolonged exposure, there is a sizeable reduction in transmittance of all three materials in the ultraviolet region and very little change in the infrared at room temperature, and transmittance is lowered in both regions at elevated temperatures. While increased optical absorption in the ultraviolet lowers transmittance, the increased absorptance of the ultraviolet bands is not sufficiently high to affect

refractive index. Extinction coefficients are also tabulated as a function of temperature for these Apollo window materials.
M.W.R.

N68-20489*# National Aero- and Astronautical Research Inst., Amsterdam (Netherlands).
ELDO FUTURE PROGRAMMES: SPIN STABILISATION OF APOGEE ROCKET. INVESTIGATION OF LATERAL ERRORS BUILT UP DURING THRUSTING OF A SPINNING APOGEE MOTOR
Jun. 1964 29 p refs Prepared for ELDO
(NLR-V-1926) CFSTI: HC$3.00/MF$0.65 CSCL 22D

An analysis has been made of the lateral velocity error built-up as a result of motor misalignment and initial coning for 2 typical motor configurations of a spinning apogee motor. The effects have been investigated by using an analog computer set up. The influence of time varying mass characteristics has been taken into account. The results show that the effects of initial coning and mass variation on the accuracy of injection are quite small.
Author (ESRO)

N68-20491# Contraves Corp., Zurich (Switzerland).
CALCULATION OF ATTITUDE CONTROL OF ESRO 1 MAGNETIC STABILIZED SATELLITE WITH ANALOG COMPUTER [BERECHNUNG DES LAGEVERHALTENS DES MAGNETISCH STABILISIERTEN SATELLITEN ESRO 1 AUF EINEM ANALOGRECHNER]
F. D. Haenni [1967] 19 p In GERMAN Presented at the Joint Ann. Meeting of WGLR/DGRR, Karlsruhe, W. Germany, Oct. 1967
(WGLR/DGRR-Paper-62) CFSTI: HC$3.00/MF$0.65

The mode of action of the attitude control system is discussed. Computation has been done with both analog and digital computers. The influence of the premagnetization of the damping sticks on the attitude control is evaluated, as well as the coupling of the roll motion with motion along the two other axes.
ESRO

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N68-19514# Lehigh Univ., Bethlehem, Pa. Fritz Engineering Lab.
BEHAVIOR OF BOLTED JOINTS WITH OVERSIZE OR SLOTTED HOLES
Ronald N. Allen and John W. Fisher Aug. 1967 65 p refs Prepared in cooperation with Bur. of Public Roads, Washington, D. C. and Penn. Dept. of Highways
(Rept.-318.3; PB-176397) CFSTI: HC$3.00/MF$0.65

Twenty-one bolted joints were tested to determine the effect of oversized or slotted holes on the slip behavior and ultimate strength of bolted joints. Hole sizes studied had standard 1/4 in., and 5/16 in. clearances. Slots parallel and transverse to the line of load were studied. All joints were fabricated from A36 steel plate and fastened by 1 in. A325 bolts. Also studied was the need for washers for oversize holes and changes in bolt tension. For holes with 1/4 in. clearance there was no decrease in the slip coefficient, excessive loss in bolt tensions, or inadequate preload. The studies indicated that a washer is desirable under the turned element to prevent severe galling. A decrease in the slip coefficient was observed for the joints with 5/16 in. hole clearance and for those with slotted holes. Slotted holes perpendicular to the line of load did not decrease the ultimate strength of the joints.
Author

N68-19515*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ELAS: A GENERAL PURPOSE COMPUTER PROGRAM FOR THE EQUILIBRIUM PROBLEMS OF LINEAR STRUCTURES. VOLUME 1: USER'S MANUAL
Senol Utku and Fevzican A. Akyuz 1 Feb. 1968 81 p
(Contract NAS7-100)
(NASA-CR-93675; JPL-TR-32-1240) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A general-purpose digital computer program (named ELAS) for the in-core solution of linear equilibrium problems of structural mechanics is described for potential and actual users in Volume I of this report and documented in Volume II. The program requires minimum amount of input for the description of the problem. The solution is obtained by means of the displacement method and the finite element technique. Almost any geometry and structure may be handled because of the availability of lineal, triangular, quadrilateral, tetrahedral, hexahedral, conical, and triangular and quadrilateral torus elements. The piecewise linear deflection distribution assumption insures monotonic convergence of the deflections from the stiffer side with decreasing mesh size. The stress are provided by the best-fit strain tensors in the least-squares sense at the mesh points where the deflections are given. The selection of local coordinate systems whenever necessary is automatic. The core memory is efficiently used by means of dynamic memory allocation, an optional mesh-point relabelling scheme, imposition of the boundary conditions during the assembly time, and the straight-line storage of the rows of the stiffness matrix within variable bandwidth and the main diagonal. The number of unsuppressed degrees of freedom that can be handled in a given problem is 500 to 600 for a typical structure, but might far exceed these avarage values for special types of problems; the execution time of such problems is about four minutes in 32K IBM 7094 Model I machines. The program is written in FORTRAN II language. The source deck consists of about 8000 cards and the object deck contains about 1400 binary cards. The physical program (standard ELAS) is available from COSMIC, the agency for the distribution of NASA computer programs.
Author

N68-19635# Lehigh Univ., Bethlehem, Pa. Fritz Engineering Lab.
A514 STEEL JOINTS FASTENED BY A490 BOLTS
Geoffrey L. Kulak and John W. Fisher Jun. 1967 55 p refs Prepared in cooperation with Bur. of Public Roads, Washington, D. C. and Penn. Dept. of Highways
(Rept.-317.8; PB-176396) CFSTI: HC$3.00/MF$0.65

The results of both analytical and experimental studies of the behavior of constructional alloy (A514) butt splices which use A490 fasteners are reported. Based on the results of previous theoretical work, the parameters that might be expected to affect the behavior of this type of joint were examined. This examination showed that the ultimate strength of these joints is a function of joint length and relative plate–fastener proportions. It is shown to be independent of fastener diameter or pitch, per se. The validity of the previously developed theoretical work and the analytical studies reported herein have been verified by means of an extensive testing program. A comparison shows that the theoretical predictions are reliable, both for the ultimate load of the joint and for obtaining the distribution of load among the fasteners at loads less than ultimate. The experimental work also showed that blast-cleaned A514 steel has a slip coefficient of about 0.33. The study further showed that constructional alloy steel joints using A490 bolts do not produce desirable behavior in their adjoining members if the elements of the joint are proportioned according to currently used stress levels.
Author

N68-19668 National Aerospace Lab., Tokyo (Japan).
SEMI-MONOCOQUE STRUCTURES SOLVED NUMERICALLY BY THE MATRIX FORCE METHOD

Tsuneo Kawashima 1967 9 p refs In JAPANESE; ENGLISH summary
(NAL-TR-141) CFSTI: $3.00

A method of stress analysis of those semi-monocoque structures with several cut-outs which are subjected to load distributions of a fairly general type has been developed. This method, the so-called matrix force method, is expected to furnish good facilities of analysis in conjunction with the potentialities of the electronic digital computer. This paper presents some considerations as to its applicability to the actual structure, the automatic forming of fundamental matrices and the cut-outs and/or modification procedures. A number of uniform cylindrical shells with a large cut-out, supported with flexible rings and stringers, are solved as numerical examples for the purpose of comparing the computed results with theoretical ones. The computation of non-uniform and non-cylindrical structures is also possible by this method. Author

N68-19570 Bettis Atomic Power Lab., Pittsburgh, Pa.
CANONICAL FORMULATIONS OF THE ELASTICITY PROBLEM AND THE APPLICATION TO DERIVING DIFFERENCE EQUATIONS
S. Kaplan May 1967 26 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-681) CFSTI: HC $3.00/MF $0.65

The minimum potential energy variational principle of elasticity theory is transformed into its canonical (Reissner's) the involutory (Castigliano's) forms. The canonical form is extended to include discontinuous functions in its domain of admissible functions. This extended principle is used to derive finite difference equations for the plane strain problem using interlacing step functions as the trial functions. Author (NSA)

N68-19618 Oklahoma State Univ., Stillwater.
THEORETICAL AND EXPERIMENTAL COMPARISON OF MATRIX METHODS FOR STRUCTURAL ANALYSIS
M. U. Ayres (Ph.D. Thesis) 1966 199 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-7181

The force and stiffness methods of structural analysis are used to predict the stress and deflection behavior of an integrally reinforced rectangular skin panel. A corresponding experimental investigation is conducted to provide a basis for the evaluation of the analytical results. The skin panel used in the experimental phase of the investigation is designed to simulate the idealizations commonly used in aerospace structural analysis. The stresses and displacements within integrally reinforced skin panel structures can be accurately determined using finite element methods of structural analysis. The derivation of a new stiffness matrix for rectangular panels based on an assumed stress distribution with linear stress variations in the x and y directions yields an improved analysis capability for the integrally reinforced skin structure.
Dissert. Abstr.

N68-19643 Oklahoma State Univ., Stillwater.
ANALYSIS OF CONTINUOUS RECTANGULAR PLATE SYSTEMS BY THE SLOPE DEFLECTION METHOD
Lawrence Norwood Dallam (Ph. D. Thesis) 1966 121 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7210

The purpose of this investigation was to develop a simple, numerical means of analyzing structural systems composed of thin, rectangular plates with various conditions of edge restraint and loaded perpendicular to the surface of the plates. A finite number of points on the edges of the plates were selected and the reactive stress resultants at these points were expressed in terms of the edge deformations (rotation and vertical displacement) at each of the selected points. The resulting expressions were called slope-deflection equations. Slope-deflection equations were also developed for the shearing force and torsional moment in the edge beams. Compatibility is restored to the continuous plate system through the application of the equilibrium equations at each edge point. Three numerical examples were worked and compared with published solutions. The numerical model consisted of five points per edge and the stiffnesses and fixed-edge moments and reactions were calculated for square plates. Dissert. Abstr.

N68-19647 Syracuse Univ., N. Y.
DYNAMIC RESPONSE AND STABILITY OF SHALLOW SPHERICAL SHELLS SUBJECT TO TIME DEPENDENT LOADING
Harold Arlen Evensen (Ph.D. Thesis) 1966 217 p
Available from Univ. Microfilms: HC $9.90/MF $3.00 Order No. 67-7070

This paper presents investigations of the dynamic response of perfectly clamped shallow thin elastic spherical shells under sustained uniformly distributed time-dependent pressures of the form $P(t) = P_0 + P_1(t)$, where the dynamic component, $P_1(t)$, is periodic with respect to time, t, and the average load, P_0 is constant. The investigation is conducted both analytically and experimentally, with particular attention devoted to the noncritical axisymmetrical responses, the critical dynamic load conditions, the applicability and extendibility of the solution techniques, and the existence of harmonic and asymmetrical responses. Dissert. Abstr.

N68-19686 Oklahoma State Univ., Stillwater.
ELASTIC BOUNDARY LAYERS IN AXISYMMETRIC CYLINDRICAL BODIES
Selma Bart Childs (Ph.D. Thesis) 1966 35 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-7206

The purpose of this research has been to investigate the elastic boundary layers associated with self-equilibrating sets of tractions and/or displacements on the finite end of a semi-infinite circular bar. The curved surface of the bar was taken to be stress free. A Love function of the form of a series of Bessel functions times exponential functions plus an improper integral, a Fourier integral, was considered as a possible solution. It was assumed that the series and the improper integral were equal to the corresponding term by term derivatives of the series plus the integral of the corresponding derivatives of the integrand. For the mixed boundary conditions, the Fourier coefficients may be explicitly determined from simple integrals. For the stress and displacement boundary conditions, an infinite set of infinite equations must be truncated and solved. Dissert. Abstr.

N68-19694 Maryland Univ., College Park.
A STUDY OF THE SELF-EXCITED VIBRATIONS OF SPRING SUPPORTED CYLINDERS IN A STEADY FLUID STREAM
Robert John Glass (Ph.D. Thesis) 1966 208 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-6119

The steady state response for the self-excited transverse vibrations of a circular cylinder mounted on linear springs in a steady fluid stream was considered. The method of dimensional analysis was applied to establish dimensionless groups which were employed as the basis for experimental plans as well as in the analysis and correlation of data. The tests were conducted in air and the range of variations was: aspect ratio, 8.14 to 16.1; the ratio of cylinder density to fluid density: 60 to 844; amplitude to diameter ratio: zero to 0.962. The Reynolds number range was 2×10^3 to 19×10^3 which lies in the region where, for a stationary cylinder, the frequency of vortex-shedding is given by a Strouhal number of 0.19. Even though the system damping was minimized and was

so small that it had no influence on the natural frequency, it was found that a small increase in damping tended to result in a smaller response amplitude. Dissert. Abstr.

N68-19699*# North American Aviation, Inc., Downey, Calif. Space Div.
STUDY OF APOLLO WATER IMPACT. VOLUME 7: MODIFICATION OF SHELL OF REVOLUTION ANALYSIS Final Report
A. P. Cappelli and S. C. Furuike May 1967 35 p refs
(Contract NAS9-4552)
(NASA-CR-92023; SID-67-498, V. 7) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A numerical procedure is presented for the solution of reduced field equations for shells. The technique developed is an improved version of the numerical scheme for the solution of shell problems. Eccentric discontinuities and branched shells are included. The procedure is general and can be applied to any consistent set of shell equations based on any shell theory. Author

N68-19700# Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics.
ANALYSIS OF SHORT WEB STIFFENED SANDWICH SHELL WITH CLOSED ENDS UNDER EXTERNAL PRESSURE
H. A. Peterson and L. W. Hu Nov. 1967 33 p refs
(Grant AF-AFOSR-127-67)
(AFOSR-67-2838; AD-665139)

An analytical method was developed for determining the deflections and stresses in short web-stiffened sandwich shells. A numerical example to demonstrate the use of the method for design was included. Author (TAB)

N68-19740 Syracuse Univ., N. Y.
A STUDY OF THE EFFECT OF SUPERIMPOSED STRESS CONCENTRATIONS AND FRACTURE OF INHOMOGENEOUS BRITTLE SOLIDS
Akio Takimoto (Ph.D. Thesis) 1966 153 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-7097

The stress field interactions between neighboring stress raises (simulated flaws; a variety of edge notches, and holes) were investigated under the uniaxial tensile load to obtain the basic information required for a fracture analysis of inhomogeneous brittle materials, such as ceramics. Strong stress field interactions have been observed in the specimen geometries employed. A unified analysis of the experimental stress field interactions is proposed. The experimental stress field interaction results indicate that the presented interaction equation represents a good upper bound. Most data lie between the theoretically predicted value and 60% of it. Fracture tests on the CR-39 and the titanium alloy RS-140 sheet specimens qualitatively indicate the predicted stress field interactions. Various methods of treating the interactions in statistical arrangements of flaws are presented and compared with experimental results of section size and porosity effects on the strength of inhomogeneous solids. Dissert. Abstr.

N68-19743*# North American Aviation, Inc., Downey, Calif. Space Div.
STUDY OF APOLLO WATER IMPACT. VOLUME 1: HYDRODYNAMIC ANALYSIS OF APOLLO WATER IMPACT Final Report
T. Li and T. Sigimura May 1967 60 p refs
(Contract NAS9-4552)
(NASA-CR-92019; SID-67-498, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The analysis presented in this volume is confined to the impact of the Apollo Command Module on water using a rigid sphere as a mathematical model. A general potential for the oblique impact is derived using a method developed by the first author of this volume. This method differs from the existing approaches in that the condition for the flow to be tangential to the varying wetted portion of the spherical surface is satisfied for all values of t, where t denotes time; while using the conventional method, the potential has to be calculated for each increment of time. Particular series expansions are obtained in the case of vertical impact for the velocity of penetration, the free surface, and the pressure. These are power series in the depth of penetration. They are obtained from the nonlinear differential equations instead of from the linearized ones. A computer feasibility study is included in this volume. Author

N68-19758# Sandia Corp., Albuquerque, N. Mex.
LARGE DEFLECTION DYNAMIC RESPONSE OF CLAMPED CIRCULAR PLATES SUBJECTED TO EXPLOSIVE LOADING
T. A. Duffey Aug. 1967 122 p refs
(Contract AT(29-1)-789)
(SC-RR-67-532) CFSTI: HC $3.00/MF $0.65

Clamped circular plates were impulsively loaded with sheet explosive, and the resulting large deflection dynamic response was monitored using high speed streak and framing cameras, and dynamic strain measurements. Both 6061-T6 aluminum (elastic–plastic, strain hardening) and 1022 steel (elastic–plastic, strain hardening, and strain rate sensitive) plates were tested. A simple rigid-plastic analysis, which predicts final deflection of the plate, is included. Author (NSA)

N68-19761*# North American Aviation, Inc., El Segundo, Calif. Space Div.
STUDY OF APOLLO WATER IMPACT. VOLUME 2: DYNAMIC RESPONSE OF SHELLS OF REVOLUTION DURING VERTICAL IMPACT INTO WATER—NO INTERACTION Final Report
A. P. Cappelli and J. P. D. Wilkinson May 1967 58 p refs
(Contract NAS9-4552)
(NASA-CR-92020; SID-67-498, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A general method is developed for predicting the response of thin elastic shells of revolution subjected to arbitrary time-dependent loads. The method solves the dynamic shell equations by means of a definite-difference formulation in both space and time. As an application of the general numerical method, the response of blunt shells of revolution during a vertical impact into an incompressible fluid is studied. A formula is derived for the pressures on a rigid body of revolution during vertical impact. It is shown that the pressures are minimum at the impact point, and very large near the edge of the wetted surface of the body. These pressures are applied as a forcing function to a shell representing a typical re-entry vehicle. The numerical results show that the response is largest at the impact point, and the interaction of the flexible structure and the fluid may have an effect on the pressure distributions. Author

N68-19768*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
HYPERVELOCITY IMPACT DAMAGE IN ALUMINUM TARGETS Final Report
R. N. Teng Mar. 1968 64 p ref Revised
(Contract NAS9-7452)
(NASA-CR-92016; DAC-59816) CFSTI: HC $3.00/MF $0.65 CSCL 20K

An experimental test program was conducted to determine the ballistic limits of aluminum targets under simulated meteoroid environments and to investigate the effectiveness of meteoroid shields as a function of the meteoroid's geometry, density, energy, and momentum. Forty data points of ballistic limits and hypervelocity

impact on semi-infinite aluminum targets were obtained from a total of over 150 attempts. The problems encountered in launching syntactic-foam projectiles during the experiment and the techniques developed to overcome these difficulties are discussed. Author

N68-19810# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
PREDICTION OF THE ELASTIC MODULI OF COMPOSITES
Ronald C. Rossi Dec. 1967 59 p refs
(Contract F04695-67-C-0158)
(TR-0158(9250-03)-1; SAMSO-TR-68-15; AD-665106)

The description of the elastic behavior of composite materials by mathematical expressions presently in the literature is restricted by the microstructural models upon which they were based. An extension was made to one of these expressions in which the shape of the included phase is considered as well as the moduli of the individual phases. The results allow a more general application of the theoretical expressions to composite materials in which the included phase is contained at low concentrations. Author (TAB)

N68-19836*# Martin Co., Denver, Colo.
DESIGN, FABRICATION AND TESTING OF SUBSCALE PROPELLANT TANKS WITH CAPILLARY TRAPS Final Report, 26 Jun. 1967–15 Mar. 1968
Thomas R. Barksdale and Howard L. Paynter Mar. 1968 50 p refs
(Contract NAS8-20837)
(NASA-CR-61676; MCR-68-11) CFSTI: HC $3.00/MF $0.65 CSCL 20K

An experimental study was conducted in Martin–Marietta's drop tower to determine the hydrostatic stability characteristics of perforated plates and square-weave screens. Tests were made over a controllable and repeatable acceleration range from 0.0013- to 0.055-g during the 2.1-sec drop interval using test liquids that simulated storable liquid propellants. The acceleration was applied normal to the flat, foraminous barriers tending to resettle liquid from beneath the barriers to the opposite end of the cylindrical tanks. Test results for the bare plates and screens verified that the Bo number, a dimensionless ratio of acceleration-to-capillary forces, is the criterion for predicting hydrostatic stability of the liquid-gas interface. The critical Bo number, delineating the stable and unstable regions, was verified for the plates with circular holes to be 0.84 based on pore radius. Test data for the screens tend to support a critical Bo number value of 0.45 based on one-half of the open width of the square weave screen. Author

N68-19852 Oklahoma State Univ., Stillwater.
A HYDRODYNAMIC MODEL OF MICROMETEOROID IMPACT
Benard Anton Sodek, Jr. (Ph.D. Thesis) 1966 88 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-7291

A mechanism is proposed to account for hypervelocity cratering. Fluid behavior is assumed for projectile and target for a normal impact of a spherical microparticle. The Eulerian equations used are developed and modified to describe shock wave formation, propagation, and free surface motion. The partial differential equations of the hydrodynamic model are converted to a dimensionless form and solved with a digital computer. Solutions are obtained for a 10^{-9} gram aluminum projectile impinging on a semi-infinite aluminum target at a velocity of 36 km/sec. Significant results show the formation of two shock waves. A primary wave into the target and a wave into the projectile. Solutions show the subsequent dissipation of each wave. The start of crater formation and the ejection of material from the edge of the depression are also described. Defects of the hydrodynamic model and proposed corrections are also indicated. Dissert. Abstr.

N68-19859# Washington Univ., Seattle. Dept. of Mechanical Engineering.
CRACK OPENING DISPLACEMENTS AND NORMAL STRAINS IN CENTRALLY NOTCHED PLATES Technical Report, Apr. 1966–Feb. 1968
A. S. Kobayashi, W. L. Engstrom (Boeing Co., Renton, Wash.), and B. R. Simon 15 Feb. 1968 31 p refs
(Contract Nonr-477(39))
(TR-4; AD-665285)

Experimentally determined crack opening displacements of stationary and running cracks and of inclined stationary cracks in centrally notched plates are reported. The moire fringe technique was used for the determination of displacement fields in test specimen of magnesium, and 7075-T6 and 7178-T6 aluminum alloys. Experimentally determined crack opening displacements were compared with corresponding results based on theoretical models of Westergaard, Dugdale, Cragg, and Cragg-Dugdale. In addition normal strain fields derived from the moire fringe data were compared with static or dynamic strain fields of these theoretical models. The results of this investigation indicate that while the Dugdale crack is a fair model of a stationary crack in ductile materials, the Cragg crack appears to be a better representation of a running crack in the ductile material investigated. Author (TAB)

N68-19887*# North American Aviation, Inc., El Segundo, Calif. Space Div.
STUDY OF APOLLO WATER IMPACT. VOLUME 8: UNSYMMETRIC SHELLS OF REVOLUTION ANALYSIS Final Report
A. P. Cappelli, T. Nishimoto, P. P. Radkowski, and K. E. Pauley May 1967 78 p refs
(Contract NAS9-4552)
(NASA-CR-92024; SID-67-498, V. 8) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A general numerical procedure is presented for determining the static and dynamic response of shells of revolutions with arbitrary distributions of stiffness subjected to arbitrary loads and temperatures. The method consists of a Fourier analysis to separate the circumferential variation in the governing equations. This results in equations with the coefficients coupled in the Fourier index. The matrix form of this equation is reduced to an algebraic form by finite difference. The unknown Fourier components of the solution are obtained by a matrix elimination procedure of this form of the governing equations. The numerical analysis is mechanized for solution on the digital computer. Numerical examples and comparisons are presented. The procedure is general and yields accurate solutions for complicated structural response for both static and dynamic conditions. Author

N68-19876 Pennsylvania Univ., Philadelphia.
THE STABILITY OF DYNAMIC AND ELASTIC SYSTEMS WITH ALMOST PERIODIC OR NEARLY PERIODIC EXCITATION
Jacob Michael Abel (Ph.D. Thesis) 1966 207 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-7811

This dissertation treats the linear second order equation with a real, even, almost periodic coefficient. The coefficient or excitation is presented as the sum of N periodic terms, $2q_i\cos 2\lambda_i t$, in which the frequencies $2\lambda_i$ are linearly independent. Asymptotic solutions of the equation are obtained in the form of N-parameter perturbation expansions. This equation may be regarded as a generalization of the Mathieu equation, and the results obtained generalize the principal results in the Mathieu theory. Bounded characteristic solutions and corresponding characteristic values are identified and classified in terms of generalized definitions of fractional and integral orders. The N-parameter perturbation expansions for the corresponding characteristic values are obtained. The geometry of the N+1 dimensional stability diagram is described. Dissert. Abstr.

N68-19890 Oklahoma State Univ., Stillwater.
CONTACT CHATTER CHARACTERISTICS OF A LINEAR VISCOUS DAMPED CONTACT SYSTEM
Alvin Fleming Baker (Ph.D. Thesis) 1966 124 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7182

An idealized linear viscous damped preloaded contact system subjected to a steady state sinusoidal vibration environment is studied to determine its chatter characteristics. The equations of the response and amplitude for impending contact separation or chatter are derived; with the use of these equations a new parameter, the Baron Number, is developed to permit the determination of the chatter characteristics of a linear damped or undamped contact system. The equation of the amplitude for impending separation and the Baron Number are validated from tests on the experimental model. The relative amplitude for impending contact separation of a linear viscous damped preloaded contact system is determined by the contact system parameters and preload. The chatter characteristics of a contact system are determined by the response of the system and the amplitude for impending separation. Dissert. Abstr.

N68-19894# Illinois Univ., Urbana.
FINITE ELEMENT ANALYSIS OF SKEWED SHALLOW SHELLS
D. A. W. Pecknold and W. C. Schnobrich Jan. 1968 171 p refs *Its* Civil Eng. Studies Struct. Res. Ser. No. 332
(Contract N00014-67-A-0305-0010)
(AD-664822)

The finite element method is applied to the problem of the static stress analysis of shallow shells under a wide variety of boundary conditions, including elastic edge stiffening. The shallow shell theory is recast in terms of oblique coordinates to facilitate the analysis of shells which are parallelogram-shaped in planform. Curved elements are employed in the application of the finite element method so that geometrical idealizations may be eliminated, and stiffness matrices based on two different displacement assumptions are derived. Comparisons, showing good agreement, are made with exact and other numerical solutions for several shallow shells. Numerical results are also presented showing the effects of skewedness, edge beam eccentricity, and a tie rod connecting the low corners on the behavior of a hyperbolic parabolid bounded by characteristics. Author (TAB)

N68-19931# Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics.
ELASTIC BUCKLING AND PLASTIC COLLAPSE OF CIRCULAR TUBES UNDER HYDROSTATIC PRESSURE
L. W. Hu and W. Geiger Nov. 1967 35 p refs
(Grant AF-AFOSR-127-67)
(AFOSR-67-2839; AD-665138)

An experimental method for studying elastic buckling and plastic collapse of circular tubes subjected to external pressure with superimposed hydrostatic load was developed. Tests on tubes of alpha brass and phosphor copper with t/D ratio ranging from 0.048 to 0.250 were conducted under hydrostatic pressures up to 100,000 psi. Preliminary results showed that the effect of hydrostatic pressure on the load carrying capacities of materials tested was insignificant but the effect on deformation was definite. Author (TAB)

N68-19943# Aerospace Corp., El Segundo, Calif. Applied Mechanics Div.
ANALYSIS OF AN ORTHOTROPIC PRESSURIZED CYLINDRICAL SHELL SUBJECTED TO RADIAL LINE LOADS ALONG EQUALLY SPACED GENERATORS
Paul E. Wilson Dec. 1967 39 p refs
(Contract F04695-67-C-0158)
(TR-0158(3240-30)-4; SAMSO-TR-68-39; AD-664908)

This report presents an analysis of the stresses and deflections in a long, orthotropic pressurized circular cylindrical shell subjected to radial line loads along generators equally spaced around the periphery. Equations that govern large deflections of circular cylindrical shells are suitably linearized to account for the influence of pressure coupling. Closed form solutions of the governing differential equations are given, and results of a parameter study employing a digital computer are presented. Results of the pressure coupling analysis are compared with those of a conventional linear analysis, and it is shown that stress and deflection data obtained from a linear analysis can be highly conservative, depending on loading and geometric parameters. Specialized forms of the present analysis are contrasted with related solutions given by Goldberg, Roark, and Donnell. Author (TAB)

N68-19978# Naval Research Lab., Washington, D. C.
THE EFFECTS OF COUPLING NUCLEAR RADIATION WITH STATIC AND CYCLIC SERVICE STRESSES AND OF PERIODIC PROOF TESTING ON PRESSURE VESSEL MATERIAL BEHAVIOR
J. R. Hawthorne and F. J. Loss 1 Aug. 1967 45 p refs
(NRL-6620; AD-664646)

The nuclear service performance of structural steels as influenced by static and cyclic stress applications during radiation exposure was examined and documented with experimental results. The significance and merits of initial and subsequent proof tests of large structural components such as the hydro-testing of nuclear reactor pressure vessels were also reviewed and evaluated. Performance following preload in the form of warm prestressing as well as aging embrittlement were among those factors considered. Author (TAB)

N68-19994*# North American Aviation, Inc., El Segundo, Calif. Space Div.
STUDY OF APOLLO WATER IMPACT. VOLUME 4; COMPARISON WITH EXPERIMENTS Final Report
J. P. D. Wilkinson May 1967 80 p refs
(Contract NAS9-4552)
(NASA-CR-92022; SID-67-498, V. 4) CFSTI: $3.00 CSCL 20K

In this volume, the pressures, vehicle accelerations, and vehicle velocities which have been obtained in the theoretical analyses described in Volumes 2 and 3 are compared with full-scale and quarter-scale experimental results. In addition, empirical expressions in the form of polynomials are derived by a least squares fit of the full-scale pressure profiles. In comparison with the full-scale test results it is observed that low-pitch angles give higher accelerations, whereas high-pitch angles give lower accelerations. The effect of high horizontal velocity is also seen to result in lower accelerations. It may be that a combination of high pitch angle and high horizontal velocity produces a wedge-like impact, where the impact takes place on the toroidal portion of the heat shield. Author

N68-20013*# General Motors Corp., Santa Barbara, Calif.
TEDDY—A TWO-DIMENSIONAL LAGRANGIAN CODE FOR DETERMINING THE WAVE PROPAGATION IN ELASTIC-PLASTIC MEDIA
A. H. Jones and C. E. Kriech Dec. 1966 190 p refs
(Contract NAS9-3081)
(NASA-CR-92034; TR66-85) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Details are given on the finite difference methods used to solve the problem of wave propagation in compressible media in two space dimensions, with either rectangular or cylindrical geometry. The equations of motion for conservation of mass, of momentum, and of energy are given, and the finite difference equations are derived. Equations for material rotation are formulated. Lagrangian grid representation is used. For this system, the motion

of the medium is described with reference to a mesh attached to the material. It is pointed out that this limits the method, and serious difficulties can arise when physical situations involve severe distortions of the original mesh. The program, which is divided into a main program and three links, can be used with either a fluid or elastic–perfectly plastic solid. Example problems with printed and plotted outputs are presented. Flow charts for the program, and complete listings of the Fortran source decks are included. M.G.J.

N68-20017# New Mexico Univ., Albuquerque. Dept. of Civil Engineering.
DYNAMIC ANALYSIS OF COMPLEX SUPERSONIC SLEDS Final Report
M. M. Cottrell, Charles E. Bacchus, and Amitava Ghose Holloman AFB, N. Mex. AF Missile Develop. Center Jan. 1968 129 p refs
(Contract AF 29(600)-4928)
(MDC-TR-68-3; AD-664907)

The report describes the approach and the digital computer program used in the approximate analysis of the structural response of a complex supersonic sled under dynamic loading. A lumped-mass model was constructed, the stiffness matrix developed, natural frequencies and mode shapes calculated, and the forced response of a constrained model predicted. Forced response for an eight-degree of freedom system is determined. The program can undergo further refinement for more general solutions. Author (TAB)

N68-20028# Michigan State Univ., East Lansing. Ultrasonics Lab.
ELASTIC WAVE PROPAGATION IN ANISOTROPIC MEDIA
Juergen H. Staudte (M.S. Thesis) 15 Dec. 1967 66 p refs
(Contract Nonr-2587(01); NSF GP-4210)
(TR-18; AD-664666)

The propagation of plane elastic waves in an anisotropic material is investigated. Using a compact tensor notation, the theory is developed, such that the fundamental quantities necessary to describe wave propagation can be calculated. These include the velocities of the wavefronts of the acoustic beam, the particle displacement vectors, and the directions of the energy flow. A computer program, which numerically calculates these quantities, is included. Author (TAB)

N68-20057# Technische Hochschule Munchen (West Germany).
PROCESSES FOR DETERMINING THE VIBRATORY LOADING RATES OF STRUCTURAL PARTS FROM EXTREMUM VALUES OF FREQUENCY DISTRIBUTIONS [VERFAHREN ZUR ERMITTLUNG VON BEMESSUNGSLASTEN SCHWINGBRUCHGEFAEHRDETER BAUTEILE AUS EXTREMWERTEN VON HAEUFIGKEITSVERTEILUNGEN]
Otto Buxbaum (Ph.D. Thesis) [1967] 68 p refs In GERMAN

The principle of extremum value distribution is used to develop a method for determining the collective loading rates made up of the following four values: collective distribution function, collective frequency, collective maximum values, and deviations. The use of the collective deviation value in addition to the known deviations for material and shape permits the definition of a total failure probability of a structure. Application of the method is demonstrated by obtaining extensive loading rates for the suspension systems of passenger cable lifts. The method avoids the large deviations in maximum values that are inherent in extrapolation and permits more accurate lifetime predictions. Transl. by K.W.

N68-20069*# North American Aviation, Inc., El Segundo, Calif. Space Div.
STUDY OF APOLLO WATER IMPACT. VOLUME 9: MODE SHAPES AND NATURAL FREQUENCIES ANALYSIS Final Report
A. P. Cappelli May 1967 35 p refs
(Contract NAS9-4552)
(NASA-CR-92125; SID-67-498, V. 9) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A general numerical procedure is presented for the analysis of the free vibrations of shells of revolution. The analysis is based on the linear shell theory of Sanders extended to the dynamical form. A Fourier analysis is used to separate variables and uncouple the governing equations in the circumferential variable. These equations together with the boundary conditions constitute the eigenvalue problem. The natural frequencies of the shell are the roots of a determinant where elements are related to certain solutions of the homogeneous field equations. An extension of the Gaussian elimination technique is employed to obtain the characteristic frequency equation in matrix form. The extension of the problem of shells of revolution with arbitrary distribution of mass and stiffness properties is included. The Fourier analysis of the governing equations for the separation of the circumferential variable yields equations coupled in the coefficients rather than the uncoupled form for shells of revolution. The numerical procedure for these equations in matrix form are handled in the manner outlined for the shells of revolution. Author

N68-20080 Purdue Univ., Lafayette, Ind.
A STUDY OF THE STABILITY OF GUYED TOWERS
John Thixton Gaunt (Ph.D. Thesis) 1966 92 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-5431

A method is presented for determining the wind load for which the guyed tower becomes unstable. A complete load-displacement history is determined, treating the structure as a conservative nonlinear system. Instability, which has been defined as a large increase in deflections for a small increase in applied load, occurs as the determinant of the stiffness matrix approaches zero. The necessary force-displacement relations for the guys and the mast spans and the governing joint equilibrium equations are formulated in terms of the displacements of the guy attachment points. The resulting set of nonlinear algebraic equations is transformed into a set of first-order nonlinear differential equations by differentiating with respect to a parameter of the applied loading. The solution is then carried out with the aid of an electronic digital computer, utilizing matrix operations and the Runge–Kutta fourth-order scheme for numerical integration of the differential equations. Dissert. Abstr.

N68-20108*# North American Aviation, Inc., El Segundo, Calif. Space Div.
STUDY OF APOLLO WATER IMPACT. VOLUME 3: DYNAMIC RESPONSE OF SHELLS OF REVOLUTION DURING VERTICAL IMPACT INTO WATER—HYDROELASTIC INTERACTION Final Report
J. P. D. Wilkinson, A. P. Capelli, and R. N. Salzman May 1967 65 p refs
(Contract NAS9-4552)
(NASA-CR-92021; SID-67-498, V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The object of this study is to describe the hydro-elastic interaction between a shell of revolution and an incompressible fluid upon vertical impact. During the impact, the deformation of the body (in particular, its rate of deformation) interacts with the fluid flow to produce oscillating pressure distributions on the wetted surface of the body. The hydroelastic response of the flexible shell is obtained by the numerical solution of the combined hydrodynamic and shell equations. The results obtained herein are compared numerically with those derived by neglecting the interaction and applying rigid-body pressures to the same elastic shell. The numerical results show that for an axially symmetric impact of the particular shell studied, the interaction between the shell and the fluid

produces appreciable differences in the overall acceleration of the center of gravity of the shell, and in the distribution of the pressures and responses. Author

N68-20109# South Dakota State Univ., Brookings.
LABORATORY INVESTIGATION OF THE HORIZONTAL SHEAR STRENGTH OF GROUT KEYS AND TONGUE AND FORK CONNECTORS Interim Report
Emil R. Hargett 21 Jun. 1967 19 p ref Prepared for Bur. of Public Roads and S. Dakota Dept. of Highways
(PB-176868) CFSTI: HC $3.00/MF $0.65

This interim report describes a laboratory investigation of the horizontal shear strength of grout keys and tongue and fork connectors proposed for use in a composite pavement consisting of precast and prestressed concrete panels post-tensioned in place and covered with asphaltic concrete. The report describes the laboratory testing of prototype keys and connections with simulated horizontal shearing forces, present test data, an evaluation of the data, and a discussion of the evaluation with respect to the applicability of the test results to the overall study on the concept of this type of composite pavement. The author concludes on the basis of this investigation: that 100 percent of the panel prestress can be transmitted through the grout keys and connectors to adjacent panels; that the strength of the connectors became critical with 0.3 of an inch of panel displacement and panel stress of 125 psi; and that horizontal panel displacement resisted by friction and the connectors amounted to an increase in panel stress of 1.52 psi per 0.001 inch of displacement. TAB

N68-20122# Stanford Univ., Calif. Div. of Engineering Mechanics.
EXTERNAL CRACK PROPAGATION (CLEAVAGE) IN A CONTINUUM MODEL WITH NONLINEAR ATOMIC SEPARATION LAWS
J. N. Goodier and J. M. Anderson Oct. 1967 121 p refs
(Contract N00014-67-A-0112-0002)
(TR-175; AD-664691)

The problem of a linear elastic solid containing two coplanar external cracks is considered. The distribution of stress in the solid when forces are applied to the crack faces is obtained. Griffith criteria are developed for the extension of the cracks under several principal cases of loading. For application to ductile materials, plastic deformation in the vicinity of the crack tips is investigated on the basis of Dugdales hypotheses. The Goodier-Kanninen model is used to determine the distribution of cohesive forces near the crack tips for four nonlinear atomic force-separation laws. The results suggest that the distribution is the same for most mobile equilibrium cracks and thus lends support to Barenblatts hypothesis. The extension criterion obtained with the Goodier-Kanninen model is compared with that of the Griffith theory. Author (TAB)

N68-20140# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
MECHANICS OF MICROMORPHIC CONTINUA
A. Cemal Eringen Jul. 1967 37 p refs Presented at the IUTAM Symp. on "The Gen. Cosserat Continuum and the Continuum Theory of Dislocations with Appl.," Stuttgart, 28 Aug.–2 Sep. 1967
(Contract N00014-67-A-0151-0004)
(TR-2; AD-665284)

The theory of micromorphic continua, developed by Eringen and his co-workers, is recapitulated and extended. Master equations are obtained in the form of integral operators from which all order volume and surface statistical moments are derivable, leading to a hierarchy of balance laws. Micropolar and indeterminate couple stress theories are summarized as special cases. The relation to other recent microstructure theories is discussed briefly.
Author (TAB)

N68-20144# Argonne National Lab., Ill.
METHOD FOR IDENTIFYING AND EVALUATING LINEAR DAMPING MODELS IN BEAM VIBRATIONS
M. W. Wambsganss, Jr. B. L. Boers, and G. S. Rosenberg Apr. 1967 30 p refs
(Contract W-31-109-ENG-38)
(ANL-7292) CFSTI: HC $3.00/MF $0.65

The results of an effort to identify and evaluate effective linear damping models in beam vibration are presented. The study was motivated by the desire to mathematically model the dynamic response of a beam-type element in which significant energy dissipation could be attributed to the contact of the component with adjacent similar components. The usual method of modeling damping is employed, that is, assuming damping mechanisms and empirically evaluating the coefficients. The three damping mechanisms considered are designated viscous, stress, and load damping. The problem is that of identifying the dominant damping mechanism(s) for inclusion in the mathematical model, and of evaluating the associated damping coefficients. A theoretical analysis is carried out, based on the usual assumptions in (Euler) beam theory and the further assumption of the damping being sufficiently small that the natural frequencies and mode shapes are unaffected. The analysis leads to a sensitive method, compatible with results obtained from tests on a vibration exciter, for identifying the effective damping mechanisms. The technique involves a comparison of the experimentally determined ratio of first- to second-mode magnification factors, related to a common point on the beam, with the constant values of this ratio corresponding to the "pure forms" of the proposed damping. The method is illustrated by application to the modeling of the response of a cluster of cantilevered beams clamped together at the base. This model is being employed in the preliminary analysis of the interaction effects of vibrating fuel rods in a nuclear-reactor core. Damping models are identified, and curves of damping coefficients as a function of cluster size are presented. Author (NSA)

N68-20148# Catholic Univ. of America, Washington, D. C. Stress Analysis Lab.
DEVELOPMENT OF EXPERIMENTAL STRESS ANALYSIS METHODS TO DETERMINE STRESSES AND STRAINS IN SOLID PROPELLANT GRAINS. STRESSES IN A SPLIT CYLINDER BONDED TO A CASE AND SUBJECTED TO RESTRAINED SHRINKAGE
A. J. Durelli, V. J. Parks, and Hans-chow Lee Jan. 1968 35 p refs
(Contract Nonr-2249(06))
(Rept.-14; AD-665031)

The paper deals with a three-dimensional photoelastic determination of stresses in a split cylinder bonded to a case. The loading of the model is due to restrained shrinkage. The results obtained will be of interest in designing solid propellant grains.
Author (TAB)

N68-20181# California Univ., La Jolla. Dept. of the Aerospace and Mechanical Engineering Sciences.
VARIATIONAL PRINCIPLES FOR ELASTIC PLATES WITH RELAXED CONTINUITY REQUIREMENTS
William Prager Jan. 1968 18 p refs
(Contract N00014-67-A-0109-0003)
(TR-16; AD-665289)

The classical variational principles of the theory of elastic plates impose stringent continuity conditions on the moment and deflection fields that are admitted for comparison with the natural fields. Since these continuity conditions are difficult to fulfill in a finite-element approach, the classical variational principles cannot be used to derive the basic equations of typical finite element methods. Modified variational principles are established that impose less exacting continuity conditions on the relevant fields. These principles are classified according to the number of independent fields that are involved. The application of the principles to typical finite-element analyses is indicated. Author (TAB)

N68-20235 Oklahoma State Univ., Stillwater.
ANALYSIS OF PLANAR FRAMES LOADED NORMALLY BY COMPLEMENTARY POTENTIAL ENERGY
Matthew McCartney Douglass (Ph.D. Thesis) 1966 87 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-7216

Two alternative formulations of the complementary energy are developed in matrix form. The advantage of the first formulation is the inclusion of the load function in such a form that various load conditions can be included without excessive algebraic or numerical work and without placing origins of integrations at the point of application or at the point of beginning of each load. The second formulation allows the calculation of the work expression without the evaluation of the deflection at points of load application and independent of the redundants. If both formulations are combined in one method of solution the preparation of the compatibility matrix equation is considerably simplified. The compatibility matrix equation consists of the load function column matrix, the flexibility matrix, and the redundant column matrix. The procedure is applicable to members of any shape lying in plane, of constant or variable cross section, for loads which are stationary or moving, and if effects of volume change or displacement of supports are required they can be expressed analogically as equivalent load functions. Dissert. Abstr.

N68-20236 North Carolina State Coll., Raleigh
THE ANALYSIS OF A CYLINDRICAL TANK WITH OFFSET SIDE WALLS
Charles Edward Jones (Ph.D. Thesis) 1966 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-5681

Classical thin shell membrane theory was used to develop expressions for membrane stress resultants and deformations in cylindrical and conical shells subjected to hydrostatic and in-plane compressive loads. Solutions for cylindrical and conical shells subjected to edge loadings were also obtained using thin shell bending theory. Compatibility of displacements and rotations at the intersecting boundary circles and at the base of the tank was used to obtain a set of simultaneous equations describing the redundants of the problem. Superposition of the membrane and bending analyses was then used to obtain the final stress resultants and bending moments in the tank. To facilitate the analysis of the tank, a set of tables was generated by means of a digital computer. The tables were generated for: 1. Membrane loadings on conical shells; 2. Edge loadings on cylindrical shells; 3. Edge loadings on conical shells. These tables reduced the analysis of a cylindrical tank with offset side walls to a task capable of being done on a desk calculator. Dissert. Abstr.

N68-20244# Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics.
AN ELASTO-PLASTIC ANALYSIS OF CIRCULAR RINGS WITH TEMPERATURE DEPENDENT YIELD STRESS
N. T. Patel and L. W. Hu Nov. 1967 56 p refs
(Grant AF-AFOSR-127-67)
(AFOSR-67-2836; AD-665140)

The elastic-plastic behavior of a ring under steady state radial temperature gradient is analyzed. The material is assumed to be elastic-perfectly plastic and its yield stress in simple shear to be a continuous and general monotonically decreasing positive function of temperature. Modified Trescas yield condition and the associated flow rules are used. Author (TAB)

N68-20269# Illinois Univ., Urbana. Coordinated Science Lab.
ANALYTICAL SOLUTION OF THERMAL STRESSES FOR A VISCOELASTIC HOLLOW CYLINDER
John Hsu Jan. 1968 48 p refs
(Contract DAAB-07-67-C-0199)
(R-372; AD-664767)

A solution is presented for the thermal stresses in an isotropic, homogeneous, viscoelastic, hollow cylinder enclosed by a rigid casing. The governing equation, which is of the integral-differential form, is integrated numerically. The resulting partial differential equation is solved exactly subjected to the imposed boundary conditions. For comparison, a simple four-parameter viscoelastic material is chosen since an independent analytical solution is available. A second example is presented in order to demonstrate the capability of this solution in handling large numbers of viscoelastic parameters which are usually required to characterize real solid propellant and other polymeric structural materials. Author (TAB)

N68-20286*# Lockheed Missiles and Space Co., Huntsville, Ala.
VIBRATIONAL CHARACTERISTICS OF ORTHOTROPIC SHELLS OF REVOLUTION Summary Report
K. R. Leimbach, C. E. Jones, and W. D. Whetstone Mar. 1968 73 p refs
(Contract NAS8-21095)
(NASA-CR-61692; HREC-1095-1; LMSC/HREC-A791267) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Analytical methods and a digital program for computing the vibrational mode shapes and frequencies of linear orthotropic shells of revolution are described. An approximate energy method (finite element) is employed, and solutions are computed using an iterative process similar to the Stodola–Vianello method for beam analysis. In developing the program, primary emphasis was placed on numerical accuracy, generality, mimimum input requirements, and economy of computer execution costs. One of the program's components, which is independently useful for other applications is a very general routine for computing solutions corresponding to arbitrary static loadings. Several examples are presented of solutions computed by the program. Author

N68-20309*# Lockheed Missiles and Space Co., Huntsville, Ala.
VIBRATIOANAL CHARACTERISTICS OF LINEAR SPACE FRAMES
W. D. Whetstone and C. E. Jones Mar. 1968 63 p refs
(Contract NAS8-21095)
(NASA-CR-61691; HREC-1095-1; LMSC/HREG-A784826) CFSTI: HC $3.00/MF $0.65 CSCL 20K

This report describes a method of analysis and digital program for computing the modes and frequencies of arbitrary linear space frames. Frame members may be either uniform beams or Timoshenko beams with arbitrarily varying mass and stiffness properties. Provision is also included for rigid links, lumped masses, concentrated springs, and other features useful in mathematically modeling complicated linear structures. The program is applicable to many types of problems, including, for example, spacecraft clusters such as those currently planned for the Apollo Applications Program, and clustered vehicles such as Titan III, Saturn IB, and proposed modified Saturns. The program is "automatic" in the sense that communications–both input and output–are concise. Input data consists of minimum definitions of particular problems (e.g., joint positions, member properties, restraint conditions, etc.). Output data contains complete solution information, including computer-generated plots of mode shapes. Several examples are presented of solutions computed by the program. Author

N68-20359*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ONE-DIMENSIONAL WAVE MOTION IN PRISMATIC BARS DUE TO IMPULSE LOADS WITH AND WITHOUT COULOMB DAMPING
Donald Dean Tomlin, Jr. 1 Mar. 1968 100 p refs
(NASA-TM-X-53714) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Several cases of wave motion without damping were solved to obtain background information which would aid in solving cases of wave motion with coulomb damping. The nonlinearities introduced by coulomb damping could be linearized so that they could be solved by using Laplace Transforms for the following cases: semi-infinite rod with a step stress impulse loading and a square wave stress impulse loading for $\tau \geq \alpha/c$ and $\tau = \alpha/2c$; and a finite rod with a step stress impulse loading. Author

N68-20384*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
RESPONSE CHARACTERISTICS OF IMPACTING PENETROMETERS APPROPRIATE TO LUNAR AND PLANETARY MISSIONS
John Locke McCarty and Huey D. Carden Washington Apr. 1968 81 p refs
(NASA-TN-D-4454) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The objectives of this study were to evaluate the capability of the penetrometers to identify structural characteristics which potentially might exist for materials on the surface of the moon and planets and to study the effects of variations in both the penetrometer design and the conditions at impact. The effects on penetrometer impact characteristics—primarily acceleration time histories—of such variables as impact velocity and angle, penetrometer size and mass, environmental pressure, and target structure and penetration resistance were examined. The target materials included a rigid nonyielding plate, a cobble–pebble agglomerate, two grades of quartz and basalt sands, fine silica powder, and a low-density open-cell foam. The results demonstrate that suitably designed penetrometers perform satisfactorily over a wide range of impact conditions on a rigid surface and have ample sensitivity to permit the detection of low-density materials having a bearing strength considerably below that required to support manned landings. Author

N68-20470# Ballistic Research Labs., Aberdeen Proving Ground, Md.
DYNAMICS OF LIQUID-FILLED SHELL: AIDS FOR DESIGNERS
John T. Frasier Dec. 1967 60 p refs Suppl. to BRL-MR-1477
(BRL-MR-1892; BRL-MR-1477; AD-665356)

Ballistic Research Laboratories Memorandum Report 1477 (Karpov, May 1963) AD-410 484 includes a discussion of Stewartsons stability analysis of liquid-filled projectiles, and Tables of Poles and Residues needed for quantitative design use of the analysis. Various design problems show that an extended tabulation is needed, and the present report provides this extension. The new tabulation (Appendix B) covers a nondimensional frequency range of 0.00 to 0.70 in increments of 0.02 and a range of cavity fill ratios of 20 to 100 percent in maximum increments of ten percent. A brief description of Stewartsons analysis is also given in the report. Emphasis is placed on the physical significance of the assumptions and results of the theory rather than its mathematical detail. The intent is to provide the novice designer of liquid-filled shell with an appreciation and first working knowledge of the analysis. Additionally, the summary of the theory is used to point out the significant advances that have been made in understanding liquid-filled shell problems since the publication of Ballistic Research Laboratories Memorandum Report No. 1477. Author (TAB)

N68-20476# Michigan Univ., Ann Arbor. Radiation Lab.
SCATTERING BY A SPHERICAL SHELL WITH A CIRCULAR APERTURE
Seichoong Chang Jan. 1968 58 p refs
(Contract AF 19(628)-2374)
(AFCRL-68-0036; Rept.-5548-7-T; SR-7; AD-665471)

A preliminary study of the scattering behavior of a spherical shell with a circular aperture is presented. The shell is assumed to be perfectly conducting and infinitesimally thin, and is illuminated by a plane electromagnetic wave symmetrically incident upon the aperture. Several different approaches to the solution of this problem are discussed, and the most promising one, the method of least square error, is described in detail. A numerical approach based on this scheme is devised, and values for the surface and back scattered far fields are given. In effect, the aperture and cavity provide a reactive load which modifies the scattering behavior of the complete shell (or sphere), and an example shows the cross section reduction achievable in this manner. Experimental confirmation was obtained, and the study is continuing. Author (TAB)

N68-20490# Contraves Corp., Zurich (Switzerland).
RESULTS OF VIBRATION TESTS ON ESRO 1 SATELLITE [ERGEBNISSE DER VIBRATIONSPRUEFUNGEN MIT DEM FORSCHUNGSSATELLITEN ESRO 1]
H. H. Schultz [1967] 26 p In GERMAN Presented at the Joint Ann. Meeting of WGLR/DGRR, Karlsruhe, W. Germany, Oct. 1967
(WGLR/DGRR-Paper-51) CFSTI: HC $3.00/MF $0.65

ESRO 1 satellite prototype (qualification model) tests have been successfully conducted in March 1967. Conditions of tests and test methods, as well as structure design of the satellite are presented. Examples are given of the experience gained by numerous measurements during the development period on the dynamic behavior of light metal construction. ESRO

N68-20538 Ohio State Univ., Columbus.
AXISYMMETRIC VIBRATION OF THIN CONICAL SHELLS
John Frederick Dreher (Ph.D. Thesis) 1966 102 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-6310

The Mushtari–Vlasov thin shell equations are used to determine eigenvalues and mode shapes for transverse axisymmetric vibration of conical shell segments. Exact solutions of these equations are found in the form of infinite series. Fundamental and several higher modes of vibration are described in graphical and tubular form for three examples: the thin shell clamped at its base and continuous through its apex; the thin shell unsupported at its base and continuous through its apex; and the thin shell segment clamped at its inner boundary and unsupported at its outer boundary. Comparison with previous work shows that the solutions developed are applicable for the general thin, right-circular, conical shell ranging from the cone with small apex angle to the flat circular plate. Dissert. Abstr.

N68-20539 Illinois Univ., Urbana.
STABILITY STUDY OF A FINITELY DEFORMED ELASTIC SHELL
William Lawrence Fourney (Ph.D. Thesis) 1966 53 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-6611

The stability of an inflated and extended cylindrical shell is studied within the framework of large elastic deformation theory. The study utilizes shell equations that are developed by superposing upon the solution of a membrane problem a linearized deformation that permits the inclusion of bending resistance and thickness effects upon stability. A comparison is made with the results published in an earlier treatment of the problem developed purely from a membrane point of view. In particular, results are plotted for Neo–Hookean and Mooney–Rivlin materials showing the effects of bending resistance and thickness variations on the previously found regions of stability. Dissert. Abstr.

N68-20540 Illinois Univ., Urbana.
THE ELASTIC AND PLASTIC RESPONSE OF A THIN CYLINDRICAL SHELL TO AN INTERNAL IMPULSIVE LOAD

Gordon Walter Bigg (Ph.D. Thesis) 1966 61 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-6559

An analytical and experimental investigation of the response of a thin walled cylindrical shell to an axially symmetric impulsive pressure is given. The loading is assumed over a portion of the shell. The analytical determination consists of two parts: The response of an elastic shell and the response of a shell assuming a continuous inelastic stress-strain relation. The governing equations of motion are derived from Hamilton's Principle and the calculus of variations and solved using numerical techniques. The experimental determination employs contact probes to measure the centerline response of an aluminum shell to an impulsive load generated by an exploding wire. An attempt was made to measure the form and the magnitude of the loading. A comparison is made between the analytical and experimental solutions and with published results. Dissert. Abstr.

N68-20542 Illinois Univ., Urbana.
A STUDY OF NONHOMOGENEOUS STRAIN ACCUMULATION AND A PLASTICITY MODEL FOR CYCLIC LOADING
Tom Max Mulcahy (Ph.D. Thesis) 1966 145 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-6683

To indicate that the investigation of states of nonhomogeneous strain accumulation is warranted, typical uniaxial stress-strain relations are modified to predict a strain accumulation phenomenon and then employed to describe the material behavior of beams subjected to steady-state cyclic loading conditions. One of the results which gives cause for concern is that extreme stresses are developed for continued cycling. A review of the existing plasticity models is made which indicates that they are unable to predict a strain accumulation phenomenon. Therefore, the "extended" plasticity model is developed so that a more complete investigation of nonhomogeneous strain accumulation is possible. Very simplified forms of the extended model are employed to investigate the consequences of nonhomogeneous strain accumulation in a beam subjected to a prescribed strain history and a thick-walled cylinder subjected to completely reversed angle of twist cycling and a constant axial load. Dissert. Abstr.

N68-20544# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
SOME STRUCTURAL PROBLEMS OF SPACE FLIGHT
N. J. Hoff Nov. 1967 15 p refs
(Contract AF 49(638)-1276)
(SUDAAR-328; AFOSR-67-2787; AD-665865)

Three particular problems of the strength of the structure of spacecraft and their boosters are discussed and the relationship between structural form and the purpose of the vehicle is described. It is shown that highly symmetric space frameworks can be kinematically unstable. A simple proposal is made how to appraise the probable magnitude of the initial deviations of the middle surface of the wall of a circular cylindrical shell from the exact cylindrical shape and it is demonstrated that this appraisal leads to good agreement between theory and experiment regarding the buckling stress when the shell is compressed axially. Finally it is shown that localized weld flaws of a geometric nature reduce the bursting pressure of cylindrical pressure vessels to a much lesser extent than was anticipated on the basis of studies of the effects of axisymmetric deviations. Author (TAB)

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N68-19502# Los Alamos Scientific Lab., N. Mex.
SIMILARITY OF FLOW OSCILLATIONS INDUCED BY HEAT TRANSFER IN CRYOGENIC SYSTEMS
F. J. Edeskuty and R. S. Thurston 1967 22 p refs Presented at the Symp., Eindhoven, Netherlands Prepared in cooperation with California Univ.
(Contract W-7405-ENG-26)
(LA-DC-8595; CONF-670912-1) CFSTI: HC $3.00/MF $0.65

Flow oscillations at acoustic frequencies are often observed during forced convection heat transfer to cryogenic liquids. These phenomena have occurred in two-phase flow and at supercritical pressures when the fluid undergoes a large change in density similar to a phase change. It has been postulated that the oscillations are generated during film boiling by the thermal response of the vapor film to flow disturbances. Disturbances which can be reinforced by a mechanism such as acoustic resonance become dominant in the system. Observed frequencies have been related to the harmonics of a pipe open at both ends and to Helmholtz resonance. An empirical correlation of oscillation inception conditions was previously published for liquid hydrogen in a 1/4-in. ID electrically heated tube. Through the use of dimensionless similarity numbers, this correlation is shown to apply to new data on liquid nitrogen and liquid hydrogen in 1/4-in. ID and 4-in. ID systems. The 16 fold geometrical scaling verified the suitability of applying the oscillation inception criterion to avoid oscillations in a water to liquid hydrogen heat exchanger which serves as an energy source for a turbopump used during nuclear rocket engine tests. Author (NSA)

N68-19504# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Chemistry.
FLUID PARTICLE HEAT TRANSFER COEFFICIENTS IN PACKED AND FLUIDIZED BEDS: A COMPARISON OF THE USE OF PERIODIC AND NON PERIODIC INPUTS
John Edward Healy (M.S. Thesis) May 1967 125 p refs
(Contract AT(30-1)-3639)
(RPI-3639-3) CFSTI: HC $3.00/MF $0.65

The use of pulse and step temperature inputs to obtain the frequency response of packed and fluidized beds was investigated in studying fluid-particle heat transfer in these systems. Packed and fluidized beds of copper and glass particles were studied using air as the fluid. For the glass particles, flow rates up to 4 times the minimum fluidizing velocity were investigated. A 2-inch diameter column was used, and data were taken over the particle Reynolds number range of 4 to 55. The agreement in the results from periodic, pulse, and step testing was generally found to be good, with the exception of the regions where the frequency content of the pulse or step is small (high frequency and/or low amplitude ratio). The steady-state periodic method was found to have superior accuracy in the high frequency range, while the step is best used at very low frequencies. At intermediate frequencies all three inputs produced comparable results. Most of the copper particle bed data had previously been fitted to models and no further analysis was necessary. The frequency response data obtained for the glass particle fluidized beds at velocities up to 4 times above the minimum fluidizing velocity did not fit any of the existing models. However, the data were fitted approximately to the conduction-dispersion model of Barile to determine the order of magnitude of the parameters of the model. The heat transfer coefficient and solid phase conduction parameters were as expected, but the gas phase dispersion parameter was large, indicating that the bubbles cause a dispersion effect. The frequency response data for the glass particle fluidized beds was converted to a form showing the time response to a unit rectangular step input. On this basis it was compared to the data of Wamsley and Johanson and shown to be consistent with it. The glass particle beds do not follow the infinite mixing model. The frequency response data clearly show this, particularly the amplitude ratio data, which are much too high and indicate a kind of gas dispersion effect. Author (NSA)

N68-19548# Bureau of Mines, Bruceton, Pa. Explosives Research Center.

FLAMMABILITY OF MATERIALS IN HYPERBARIC ATMOSPHERES Final Report

Joseph M. Kuchta, Elton L. Litchfield, and Aldo L. Furno 30 Aug. 1967 59 p refs

(Rept.-4016; PB-176528) CFSTI: HC $3.00/MF $0.65

To evaluate the potential fire hazards of combustion solids in hyperbaric atmospheres, hot plate ignition temperatures, flame spread rates, and minimum ignition energies were determined for various materials. The combustibles included cotton sheeting, cotton sheeting treated with fire retardants, cotton balls, paper drapes, conductive rubber sheeting, blanket wool, polyvinyl chloride sheet, Plexiglas sheet, cellulose sheet, wood strips and dowels, and a Nomex fabric. Air, oxygen, and various oxygen-nitrogen atmospheres were employed at pressures from 1 to 6 atmospheres. Determinations for selected combustibles were also made in oxygen at reduced pressures. A noteworthy finding was that materials treated with certain fire retardants can ignite in oxygen-enriched atmospheres at low temperatures than untreated materials. In addition, minimum ignition energy requirements were investigated for several anesthetic agents including cyclopropane, diethyl ether, divinyl ether, trichloroethylene, Fluoromar, Fluothane, and chloroform. Author

N68-19556# Mound Lab., Miamisburg, Ohio.

DETERMINATION OF DEBYE TEMPERATURES FROM X-RAY DATA AND THEIR USE IN CALCULATING THERMODYNAMIC PROPERTIES

D. J. Hunt and Y. G. Ishida 20 Feb. 1967 21 p refs

(Contract AT(33-1)-GEN-53)

(MLM-1396) CFSTI: HC $3.00/MF $0.65

It is shown that Debye temperatures can be successfully determined from X-ray measurements and used to give reasonable values of thermodynamic and physical properties. NSA

N68-19603 Oklahoma State Univ., Stillwater.

THE EFFECT OF SURFACE VIBRATION ON NUCLEATE POOL BOILING AT LOW HEAT FLUXES

Donald Craig Price (Ph.D. Thesis) 1966 182 p

Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-7275

A quantitative study was concerned with the measurement of the effect of surface vibrations on the heat transfer coefficient in nucleate boiling. The heat flux range in this investigation was from zero to 50,000 BTU/hr ft^2. A qualitative study was made using high speed motion film of the process with and without surface vibrations. These films were taken at a range of frequencies and amplitudes for the two key heat fluxes of 15,200 and 22,300 BTU/hr ft^2. As a result of the quantitative investigation, it was determined that the vibration of the surface produced no noticeable influence on the numerical value of the heat transfer coefficient for the range of variables studied. The qualitative study, however, indicated a widespread influence of surface vibration on the nucleation and bubble growth processes. Dissert. Abstr.

N68-19627 Oklahoma State Univ., Stillwater.

THERMAL MODELING IN A SIMULATED SPACE ENVIRONMENT

Paul LeRoy Miller, Jr. (Ph.D. Thesis) 1966 97 p

Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-7259

Methods of thermal modeling were investigated which apply to both transient and steady-state conditions for single and multiple material systems, taking into account variations of thermal properties with temperature. The similarity parameters for thermal modeling were analytically derived and the results verified by experimental techniques. The procedure which allows thermal modeling while meeting all objectives is a matter of geometric scaling. Although the experimental work was restricted to cylindrical systems, the results may be extended to flat plates and hollow cylinders. Experimental results were obtained to a degree of accuracy which permits the conclusion that the similarity parameters derived for thermal modeling are valid for use in the design of spacecraft and related applications. Dissert. Abstr.

N68-19628 Syracuse Univ., N. Y.

AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF PULSE TUBE REFRIGERATION

Ralph Cady Longsworth (Ph.D. Thesis) 1966 196 p refs

Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-7083

An investigation of the heat pumping mechanism of pulse tube refrigeration has been carried out. The results confirm the descriptions of the heat pumping mechanism given previously. In addition, an empirical relation has been developed from test results based on the analytical model which gives the heat pumping rate as a function of many of the design and operating variables over a wide range. An analytic model using a finite difference technique is developed which describes an ideal pulse tube. Assumptions made in developing the model are sudden pressure change in the tube, smooth piston-like gas flow, and no axial heat conduction. The analytic model predicts the heat pumping rate, wall temperatures and wall temperature change based on these assumptions. It is concluded that the basic heat pumping mechanism is the step-wise transfer of heat up the tube as a result of heat flowing to and from the wall with each pressurization and depressurization of the tube. Dissert. Abstr.

N68-19636 Cornell Univ., Ithaca, N. Y.

LAMINAR FREE CONVECTION ABOUT AN ISOTHERMAL SPHERE AT EXTREMELY SMALL GRASHOF NUMBERS

Md Anwar Hossain (Ph.D. Thesis) 1966 111 p

Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-1467

Laminar free convection flow and heat transfer about an isothermal sphere are studied in the Grashof number range between zero and unity and for Prandtl numbers around unity, by means of a perturbation analysis. Solutions to the governing differential equations are expressed in perturbation series with the Grashof number itself taken as the perturbation parameter. Three terms in the series expansions have been determined analytically. The non-dimensionalized velocity and temperature profiles as well as the contributions to them of the different terms in the respective series expansion for various Grashof numbers and Prandtl number of 0.72 have been presented and discussed. A vortex is observed in the region far away from the sphere. Average and local Nusselt numbers are plotted and discussed. In the range of the Grashof number between 0 and 0.1, the average Nusselt number increases linearly with the Grashof number. Dissert. Abstr.

N68-19660 California Univ., Berkeley.

INFRARED RADIATION OF GASES AT ELEVATED TEMPERATURES

Momtaz Mahdy Abu-Romia (Ph.D. Thesis) 1966 79 p

Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-4985

Measurements of the infrared absorption of pure carbon monoxide in the temperature range from 300° to 1500°K were performed for a wide range of path lengths and pressures. The spectral and band absorption data were correlated by the use of the Elsasser band model. The total emissivity of carbon monoxide was then calculated from the correlations for optical depths from 0.004 to 2 ft-atm at a total pressure of 1 atm in the temperature range

from 600° to 3000°R. A method of applying the infrared spectroscopic properties of gases to radiation heat transfer problems is presented. Based on the Elsasser band model, explicit expressions for the effective mean absorption coefficient are derived for the limiting cases of optically thin and optically thick gas. Consequently, expressions for Planck and Rosseland absorption coefficients are obtained as functions of the thermodynamic properties of the gas. Dissert. Abstr.

N68-19666 Idaho Univ., Moscow.
THERMODYNAMIC PROPERTIES OF HYPOTHETICAL FLUIDS
Chester James (Ph.D. Thesis) 1966 232 p
Available from Univ. Microfilms: HC $10.60/MF $3.00 Order No. 67-5379

Binary vapor-liquid and solid-liquid equilibrium data have been used to evaluate the fugacities, specific volumes and enthalpies of hypothetical fluids. The components studied included methane, ethane, propane, pentane, benzene and paradichlorobenzene. Data for the real component and the mixture were obtained from an equation of state or experimentally. The Margules and Van Laar Equations were employed to relate the real component data and the mixture data to the thermodynamic properties of the hypothetical fluid. It was found that his investigation that the thermodynamic properties of hypothetical fluids have unique and reproducible values. The enthalpy changes upon mixing and the volume changes upon mixing were evaluated for all the vapor-liquid systems investigated. These enthalpy and volume changes on mixing can be used in the modified Gibbs–Duhem Equation for constant temperature or constant pressure where one component of a binary system is hypothetical at the existing temperature and pressure. Dissert. Abstr.

N68-19794# Ballistic Research Labs., Aberdeen Proving Ground, Md.
COMPUTATION OF HOLLOW CYLINDER EXPLOSIONS
Alvars Celmins Nov. 1967 53 p refs Presented at the 13th Conf. of Army Mathematicians, Ft. Monmouth, N. J., 7–8 Jun. 1967
(BRL-R-1381; AD-664774)

The report treats the explosion caused by a charge which is placed between two hollow co-axial cylinders. It is assumed that at the beginning of the motion of the cylinders the explosive has been detonated completely so that the space between the cylinders is filled by a gas under high pressure. The flow of this gas during the collapse of the inner cylinder and the expansion of the outer cylinder is governed by a quasi-linear second order partial differential equation. This equation is solved numerically using a two-level difference scheme. The solution furnishes the fragment velocities of the outer cylinder and the collapse velocity of the inner cylinder. The results are compared with experimental data and asymptotic formulae. The same computation scheme is applied to the computation of the motions of two parallel plates with a charge exploded between them. Author (TAB)

N68-19799*# National Bureau of Standards, Boulder, Colo. Cryogenics Div.
CRYOGENIC PROPELLANT VENTING UNDER LOW PRESSURE CONDITIONS Final Report
M. C. Jones, Patricia J. Giarratano, and A. U. Simpson 2 Feb. 1968 109 p refs
(NASA Order R-45)
(NASA-CR-93744; NBS-9703) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Data are presented for wall temperatures and heat transfer coefficients for solid-vapor mixtures of parahydrogen and nitrogen flowing in an electrically heated straight tube of length 40 times its diameter. These are interpreted by the application of flate plate, constant property boundary layer theory to models in which the solid particle geometrical distribution takes on simple limiting forms. The observed enhancement of the heat transfer coefficient over that for gas alone traveling at the same velocity is qualitatively predicted as a function of a dimensionless heat flux, the Sterman parameter $q_w/\rho_v U\lambda$. This parameter is also shown to be an index of particle-wall interaction and is used to correlate observed limiting wall heat fluxes above which free flow may be guaranteed. Author

N68-19840*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 4: THERMODYNAMICS
Marshall C. Burrows Washington 1968 21 p refs Presented at Lewis Aerospace Explorers Conf., Cleveland, 1966–1967
(NASA-TM-X-52391) CFSTI: HC $3.00/MF $0.65 CSCL 21B

Some rules of thermodynamics which govern the operation of a rocket engine are cited, and the characteristics and combustion processes of some available propellants are examined. The advantages and disadvantages of the various liquid and solid fuels are given along with a brief history of each. The various means of injecting liquid propellants into a combustion chamber are shown, and the four processes by which liquid propellants may mix are delineated. An equation is derived that describes the combustion reaction of a liquid propellant combination, and a brief summary on the combustion of composite solid propellants is presented. The combustion chamber is discussed in relation to the injector, inhibitor, walls, and design of the chamber. A list is also included on the principal desirable features of propellants and combustion systems. B.S.D.

N68-19847 Washington Univ., Seattle.
THERMAL RADIATION EFFECTS ON THE LAMINAR FREE CONVECTION BOUNDARY LAYER OF AN ABSORBING AND A NON-ABSORBING GAS
Walter Gary England (Ph.D. Thesis) 1966 191 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-7638

The effects of thermal radiation on the laminar free convection boundary layer along a vertical plate were experimentally and analytically investigated for both absorbing and non-absorbing gases. Experimental measurements of the boundary layer velocity and temperature profiles, and the local heat flux were obtained. Theoretical solutions were obtained by assuming that all radiative properties were independent of frequency and that the fluid medium was a perfect incompressible gas are presented. The experimental measurements and theoretical results for an absorbing gas are compared. The theoretical equations are further modified to include the assumptions of constant properties and optically thin gas and the solutions are compared to find the effects of these assumptions. Experimental measurements and theoretical results for the non-absorbing gas are compared to determine effects of the radiating boundary. A correlation which predicts plate surface temperatures as a function of plate emissivity is presented. Dissert. Abstr.

N68-19863*# TRW Systems, Redondo Beach, Calif.
DETERMINATION OF THERMOPHYSICAL PROPERTIES OF ABLATIVE MATERIALS. PHASE 1: LABORATORY DETERMINATIONS. PART B: THERMAL CONDUCTIVITY AND THERMAL DIFFUSIVITY
R. C. Nordberg, R. D. Larson, and G. B. Charlan 16 Jan. 1967 38 p ref
(Contract NAS9-4518)
(NASA-CR-92018; TRW-04812-6001-R001, Pt. B) CFSTI: HC $3.00/MF $0.65 CSCL 20M

This report describes laboratory measurements of thermophysical properties of three ablative materials being used on

the Apollo Spacecraft primary propulsion systems. Two additional materials were also evaluated which have potential as improved ablative materials for Apollo applications. The thermophysical properties reported herein are comprised of thermal conductivity and thermal diffusivity. These properties were determined on Fiberite Corporation's MX 2600 and MX 2646, Western Backing Corporation's WBC 2234 and WBC 5217, and U.S. Polymeric Corporation's XR 2015. Description of the experimental techniques and test results are presented. Author

N68-19918 Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.

AN ANALYTICAL APPROACH TO THE THERMAL DESIGN OF SPACECRAFTS

Koichi Oshima and Yuko Oshima Jan. 1968 42 p refs
(ISAS-419, V. 33, No. 1)

The linearized thermal balance equations of two-nodes system, in which radiative heat dissipation to outer space from the each node and heat transfer between them are counted, are analytically solved for several special cases which closely relate to the real situations in spacecrafts. General theorems on n-nodes system are presented with relations to the real spacecraft structure. Based on these discussions, a new method of thermal analysis of spacecrafts is proposed, which is essentially an experimental analysis of simplified thermal model. The construction method of this model and the data reduction process are shown with an illustrative example. Using this method, the thermal character of a spacecraft can be determined with minimum simulator time and without extensive numerical computation. Author

N68-20014 Oklahoma State Univ., Stillwater.

BOILING IN SELF INDUCED RADIAL ACCELERATION FIELDS

Ali Owhadi (Ph.D. Thesis) 1966 170 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-7270

Forced convection boiling heat transfer to water at atmospheric pressure was studied in two helical coils with diameters of 9.86 in. and 20.5 in. The coils were constructed from 10 ft. lengths of Inconel 600 tubing. The heat was supplied electrically. At vapor qualities below 80% the heat transfer coefficient was high all around the tube, although it was usually highest on the outer side (the side farthest from the coil axis). At higher qualities, a liquid deficiency gradually occurred at the top and bottom of the tube; they became completely dry at about 95% vapor quality. The highest quality at which measurements were made was 99.1% vapor. Even at this quality both the outer and the inner sides of the tube were partially wetted. Dissert. Abstr.

N68-20042*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SOME ASPECTS OF STEADY-STATE PROPELLANT COMBUSTION AS RELATED TO DYNAMIC COUPLING MECHANISMS

Louis A. Povinelli Washington 1968 12 p refs Presented at Conf. on Mech. of Coupling of Combust. with Gas Dyn. Flow Fields, Princeton Univ., N. J., 25-26 Jan. 1968
(NASA-TM-X-52419) CFSTI: HC $3.00/MF $0.65 CSCL 21B

Energy flux to the propellant surface and effects of both pressure and velocity coupling mechanisms are considered for steady-state solid propellant combustion, and some of the realities of the reaction zone are discussed in this light. The existence of an extensive or thick zone implies that the premixed treatment is invalid and a realistic mixing or diffusion zone is required. Both linear and nonlinear calculations indicate the profound influence of velocity effects on the response value and stability limits. M.W.R.

N68-20065*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

APPROXIMATE RELATIONS FOR LAMINAR HEAT-TRANSFER AND SHEAR-STRESS FUNCTIONS IN EQUILIBRIUM DISSOCIATED AIR

Ernest V. Zoby Washington Apr. 1968 21 p refs
(NASA-TN-D-4484) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Simple, approximate equations have been developed for computing the normal derivatives of enthalpy and velocity evaluated at the surface of a flat plate or cone and of a blunt axisymmetric body. These approximate equations were developed by correlating exact similar solutions to the laminar boundary-layer equations for equilibrium dissociated air. The results of these approximate equations represent the exact solutions within ±10 percent. Author

N68-20066*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYSIS OF PRESSURE-DROP FUNCTION IN RANKINE SPACE POWER BOILERS WITH DISCUSSION OF FLOW MALDISTRIBUTION IMPLICATIONS

Andrew A. Schoenberg and Donald R. Packe Washington Apr. 1968 64 p refs
(NASA-TN-D-4498) CFSTI: HC $3.00/MF $0.65 CSCL 13A

The analysis was performed for counterflow liquid-heated single-pass boilers of the type used in Rankine space power systems such as SNAP-8. The analysis takes into account the nonuniform axial distribution of heat flux, variable geometry factors, and the variation of the lengths of the preheat, boiling, and superheat regions. Comparison with data from a single-tube water boiler indicates that the analytical model predicts the pressure drop and its dependence on various boiler-input variables with an average error of less than 10 percent. With the use of results generated from the analytical model, effects on the pressure-drop function caused by variations in some of the geometric and thermodynamic parameters of the boiler were studied. From these studies, the following causes of the multivalued characteristic were established: (1) The magnitude of the multivalued effect is strongly influenced by a boiler-tube insert, but the characteristic could exist even with an open tube. (2) The multivalued characteristic can exist for either a choked nozzle or a constant pressure at boiler discharge. Methods for eliminating the multivalued characteristic and thus the potential for flow maldistribution are evaluated. Author

N68-20116 Pennsylvania State Univ., University Park.

THERMODYNAMIC PROPERTIES OF ARGON AND NEON IN THE TWO-DIMENSIONAL CRITICAL REGION

Mary Westergaard Barnes (Ph.D. Thesis) 1966 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-5894

A homogeneous adsorbent was produced by pre-adsorbing a monolayer of xenon on graphitized carbon black. On this surface were obtained isotherms and heats of adsorption, both calorimetric and Clausius-Clapeyron. The results for argon as adsorbate were equivalent to those of other workers. Data on the adsorption of neon showed, as for argon, that the monolayer volume for adsorbate and xenon were the same, and that most of the heterogeneity present in adsorption on bare carbon was absent when a monolayer of xenon was preadsorbed. Heat capacities were measured from 50-80° for 0.5 layer of argon and from 8-21° for 0.5 layer of neon, each on one monolayer of xenon. From each experimental heat capacity was subtracted the estimated vibrational contribution to obtain the configurational heat capacity. This quantity was found to have a maximum at 72° for argon, and at 15.2° for neon. Dissert. Abstr.

N68-20136 Iowa State Univ. of Science and Technology, Ames.
HEAT TRANSFER IN THE SHOCK-INDUCED UNSTEADY BOUNDARY LAYER ON A FLAT PLATE
Elmer John Felderman (Ph.D. Thesis) 1966 133 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-5585

The development of the flow around a model mounted in a shock tube following the passage of the initial shock wave was examined. The analysis was restricted to the case of a semiinfinite flat plate with a sharp leading edge mounted at zero angle of attack. The inviscid flow behind the initial shock wave was assumed to be steady and uniform. The analysis was verified experimentally by obtaining heat transfer measurements on a flat plate mounted in a shock tube. Measuring stations were located 2.58, 4.62, and 6.55 inches back from the leading edge of the plate. Platinum thin-film heat transfer gages were used. Data were obtained at shock Mach numbers between 3.0 and 6.74 and at initial channel pressures between 0.57 and 17 mm Hg. Although some scatter is present in the data it does agree quite well with the theoretical results. Dissert. Abstr.

N68-20137 Idaho Univ., Moscow.
HEAT TRANSFER IN THERMALLY DECOMPOSING OZONE
Louis Laird Edwards, Jr. (Ph.D. Thesis) 1966 104 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-5375

The purpose was to investigate both theoretically and experimentally the effect of the homogeneous, gas phase thermal decomposition of ozone upon heat transfer in ozone-oxygen mixtures in turbulent flow past a solid surface. The ozone decomposition reaction is irreversible and highly exothermic. A mathematical model was developed using the film theory model to describe the fluid mechanics adjacent to a flat plate. Differential energy and material balances were combined with accepted reaction rate expressions, physical property data, and boundary conditions to form the complete boundary value problem. The most important boundary condition, from a physical standpoint, was that no catalytic ozone decomposition was occurring at the solid surface. Over 140 exact solutions to the boundary value problem for both heating and cooling were obtained using the equivalent of a Beckman EASE electronic-analog computer. Dissert. Abstr.

N68-20172# Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.
EXPERIMENTAL STUDIES ON DRIVING MECHANISM OF THE HIGH FREQUENCY COMBUSTION OSCILLATION IN A PREMIXED GAS ROCKET
Tadao Takeno Jan. 1968 33 p refs
(ISAS-420, V. 33, No. 2)

Experimental studies were conducted to make clear the initiating and driving mechanism of the longitudinal high frequency combustion oscillation in a rocket motor burning a premixed gas as the propellant. The effects of several variables upon the critical oscillation period, which has been found in the previous studies to govern the occurrence of the oscillation, were studied in the beginning. Then the distribution of the gas temperature in the reaction zone during the oscillation was measured in detail. Finally, the photographic study of the reaction zone during the oscillation as well as during the steady combustion was made by the high speed schlieren motion picture. The interaction between the pressure wave and the combustion process which provides the driving force of the oscillation was found to be of a rather complicated fluid-mechanical nature. The characteristic time which governs the occurrence of the oscillation was identified with the ignition time delay of the unburnt propellant in the hot combustion gas stream. The latter was found to be of a chemical nature depending chiefly upon the propellant equivalence ratio, although some small effects of the combustion chamber pressure and the injection Mach number of the propellant were found in the experiments. Author

N68-20241# European Space Technology Center, Noordwijk (Netherlands).
A STUDY OF THE THERMAL BEHAVIOUR OF THE ESRO 1 SATELLITE. PART 1: THE MATHEMATICAL MODEL [ETUDE DU COMPORTEMENT EN TEMPERATURE DU SATELLITE ESRO 1, PREMIERE PARTIE: LA MODELE MATHEMATIQUE]
M. Toussaint, ed., J. Doenecke, A. Taroni, and O. Ullmann Paris ESRO Oct. 1967 55 p refs
(ESRO-TN-20(ESTEC)) CFSTI: HC $3.00/MF $0.65

In this report a description is given of the thermal mathematical model used at ESTEC to determine the thermal behavior of the ESRO 1 satellite under the stimulus of external heat radiation. The distribution of isothermal nodes and the methods employed to link them together in the heat balance equation using radiative and constructive heat exchange factors are explained in detail. The numerical values for the study are given in separate appendices, which are available on request. ESRO

N68-20331*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RADIANT-INTERCHANGE CONFIGURATION FACTORS FOR SPHERICAL AND CONICAL SURFACES TO SPHERES
James P. Campbell and Dudley G. McConnell Washington Apr. 1968 24 p refs
(NASA-TN-D-4457) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Geometric configuration view factors have been calculated for a sphere and for cones radiating to a sphere. A computer program was set up to give configuration view factors not only for the entire radiating body but, also, for bands of the radiating body which permit the determination of the configuration view factor between any part of the radiating body and the sphere. The range of configurations consisted of equal radii spheres, and right-circular cones of semiapex angles of 15°, 30°, 45°, and 60° radiating to a sphere on the cone axis with radius equal to the cone base radius. Separations for all cases ranged from zero to 10 sphere radii. Curves are presented that give the configuration view factor for any configuration within the limits of the study. Author

N68-20336# National Center for Atmospheric Research, Boulder, Colo.
TEMPERATURE CONTROL OF BALLOON PACKAGES
Ernest W. Lichfield and Neil E. Carlson Aug. 1967 45 p
(NCAR-TN-32; PB-176089) CFSTI: HC $3.00/MF $0.65

Since the electronics and battery power supply of the IRLS system will not operate properly at this temperature extreme, NASA issued a contract to NCAR to design a thermal package that would maintain the IRLS components at a reasonable temperature during both day and night and for a long period of time (several months). As we analyzed the problems we found that there was very little published information on temperature control for balloon flights. It was therefore decided that a report should be written that could be used as a general guide for thermal packaging for ballooning. Author

N68-20338*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LOCAL HEAT TRANSFER FOR WATER IN ENTRANCE REGIONS OF TUBES WITH TAPERED FLOW AREAS AND NONUNIFORM HEAT FLUXES
Nick J. Sekas and James R. Stone Washington Apr. 1968 18 p refs
(NASA-TM-X-1554) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Local convective heat-transfer coefficients of water flowing through electrically heated circular tubes with axially varying heat fluxes and flow areas were investigated. Data were obtained in the turbulent flow regime with local Reynolds numbers from 8000 to 50 000 over a Prandtl number range of 1.6 to 4.5. Measurements

of mass flow rate, heat flux, water bulk temperatures at tube inlet and outlet, and axial temperature distribution for each run were made and are presented in tabular form. Plots of local to fully developed Nusselt number ratio as a function of heated length-to-diameter ratio are presented. These data are compared with calculated values of the local to fully developed Nusselt number ratios based on a previously reported correlation of entrance effects with tubes of constant flow area and uniform heat flux. The calculated Nusselt number ratios generally approximated the present experimental results. Author

N68-20340*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF A MULTITUBE SINGLE-PASS COUNTERFLOW NAK-COOLED MERCURY RANKINE-CYCLE CONDENSER
Ronald H. Soeder, Joseph S. Curreri, and Robert P. Macosko Washington Apr. 1968 42 p refs
(NASA-TM-X-1548) CFSTI: HC$3.00/MF$0.65 CSCL 13A

Overall steady-state performance of a SNAP-8 condenser was mapped in a test facility simulating the SNAP-8 system. This condenser provided for a single pass of mercury in 73 tapered-diameter tubes cooled by counterflowing NaK (eutectic mixture of sodium and potassium) within a similarly tapered outer shell. The investigation was conducted for mercury flow rates from 4000 to 10,000 pounds mass per hour (0.5 to 1.3 kg/sec) and condenser NaK flow rates from 12,750 to 31,350 pounds mass per hour (1.6 to 4.0 kg/sec). The condensing lengths associated with the flow conditions ranged from 13 to 40 inches (0.3 to 1 m). The static-pressure drop of the mercury over the length of the condensing region varied, in general, between −1 and +1 psi ($\pm 6.9 \times 10^3$ N/m^2) for condensing lengths of 13 to 40 inches (0.3 to 1 m). Average overall heat-transfer coefficients were calculated based on measured NaK stream temperatures. Corresponding saturated mercury vapor temperatures were obtained from the Lockhart–Martinelli correlation for an assumed liquid-to-vapor velocity ratio of 1.0. For the range of conditions investigated, the computed coefficients varied from 1980 to 3340 Btu per hour per square foot per °F (1.1 ± 10^4 to 1.9 ± 10^4 W/(m^2)(°K)). Author

N68-20374*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HEAT-TRANSFER CORRELATION FOR GAS FLOW ACROSS HEATED BANKS OF WIRE MESHES OR TUBES
Byron L. Siegal Washington Apr. 1968 25 p refs
(NASA-TN-D-4514) CFSTI: HC$3.00/MF$0.65 CSCL 20M

The heat-transfer data of this investigation for nitrogen flowing across a bank of electrically heated mesh were compared with the data of other investigators for the flow of hydrogen, nitrogen, helium, and air across single meshes, banks of meshes, and banks of tubes. The data covered the following ranges of variables: (1) Porosities from 0.37 to 0.88, (2) Wire or tube diameters from 0.0076 to 0.375 inch (0.0193 to 0.952 cm), (3) Surface temperatures to 5500°R (3050°K), (4) Outlet gas temperatures to 3160°R (1760°K), and (5) Reynolds numbers from 3 to 30,000. A heat-transfer correlation based on surface-temperature gas property evaluation, wire diameter, and average mesh flow area was found which correlated the data within ±20 percent. Author

N68-20458# Naval Ship Research and Development Center, Washington, D. C. Aerodynamics Lab.
ACOUSTIC WAVE PROPAGATION IN A CONDUCTING AND THERMALLY RADIATING IDEAL GAS
George K. Lea Jun. 1967 41 p refs
(NSRDC-2525; NSRDC-AERO-1134; AD-665519)

The combined effects of thermal conduction and radiation on one-dimensional acoustic wave propagation were investigated using the moment approximation. Three distinct waves, corresponding to a classical wave, a thermal conduction wave and a radiation induced wave were found. Asymptotic expressions, presented for the damping per cycle and the phase velocities of these waves, compare very closely with direct numerical computations. Orders of magnitude estimates on the three types of wave amplitudes based on a temperature slip boundary condition and partial solution to the problem of two-dimensional, steady flow past a wavy wall are given. Author (TAB)

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N68-19532# Sandia Corp., Albuquerque, N. Mex.
ENVIRONMENTAL DATA BANK INDEX: UNCLASSIFIED ENTRIES
M. B. Gens Jun. 1967 48 p
(Contract AT(29-1)-789)
(SC-WD-67-426) CFSTI: HC$3.00/MF$0.65

In an effort to determine the environment to which the equipment designed by Sandia Corporation will be exposed, a data bank of environmental information has been compiled. Measured quantities resulting from field tests or actual use are continually being summarized to establish envelopes of inputs and responses. This material is being collated, microfilmed, and filed under 15 basic categories of environment. By consulting this data bank, a user has at his immediate disposal numerical definitions of the environments to aid in establishing design requirements and test plans. Author (NSA)

N68-19649# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 4, NUMBER 3 Monthly Review of Selected Foreign Scientific and Technical Literature
Mar. 1968 126 p refs
CFSTI: HC$3.00/MF$0.65

CONTENTS:

1. PLASMA WAVEGUIDES FOR ACCELERATORS A. Polushkin p 1–9 refs (See N68-19650 10-11)
2. MEASUREMENT OF LASER OUTPUT B. Doncov p 10–15 refs (See N68-19651 10–14)
3. KOSMOS SATELLITES, 1967 D. W. Michaels p 16–23 refs (See N68-19652 10-31)

N68-19693*# Delaware Univ., Newark.
THE ADMINISTRATION OF RESEARCH. AN INTERPRETIVE SUMMARY OF THE PROCEEDINGS OF THE NATIONAL CONFERENCE ON THE ADMINISTRATION OF RESEARCH, 1947–1964
Leslie B. Williams and Sidney E. Clark 1966 171 p
(Contract NSR-08-001-010)
(NASA-CR-93723) CFSTI: HC$3.00/MF$0.65 CSCL 05A

An attempt is made to examine, interpret, and summarize information in the field of research management and administration that has been presented as the past eighteen National Conferences on the Administration of Research. The subjects covered include the roles of the university, industry, government, and independent organizations in research, as well as their relationships to one another, the role of the research director, the management of

research operations, the management of creativity, innovation, and motivation, and ethics in research administration and public affairs.
R.N.A.

N68-19873# RAND Corp., Santa Monica, Calif.
APPROACHES TO DEALING WITH MOTOR VEHICLE AIR POLLUTION: REPORT OF THE SUBPANEL ON TRANSPORTATION SYSTEM REQUIREMENTS OF THE PANEL ON ELECTRICALLY POWERED VEHICLES
Edward H. Blum Dec. 1967 57 p refs
(P-3776; AD-665105)

The purpose of the report is to develop a style or reason for vehicular pollution policy. The report treats aspects of vehicular pollution not directly concerned with specific technology--and constructs a systematic framework within which the vehicular pollution problem can be seen and analyzed as a whole.
Author (TAB)

N68-19896*# Connecticut Univ., Storrs. New England Research Application Center.
AN ACCOUNT OF THE ACTIVITIES AND RESULTS OF THE FIRST YEAR OF OPERATION OF THE NEW ENGLAND RESEARCH APPLICATION CENTER Final Report, 1 Apr. 1967–31 Mar. 1968
31 Mar. 1968 91 p refs (Contract NSR-07-002-029)
(NASA-CR-93763) CFSTI: HC$3.00/MF$0.65 CSCL 05A

The results of the first year of work of the New England Research Application Center as a newly established information dissemination resource, are presented. Reference is made to the context, aims and imperatives of the work and a summarized chronology of the major events given. Quantitative results are presented with analyses. The generality and specifics of the problems associated with technology transfer and utilization are ventilated. Factual evidence of 'client' satisfaction is also presented. Some general observations and comments on futuré trends conclude the report.
Author

N68-19956# Congress. Senate. Committee on Science and Astronautics.
NASA AUTHORIZATION FOR FISCAL YEAR 1969. PART 1, NUMBER 3
Washington GPO 1968 302 p Hearings before Comm. on Sci. and Astronautics, 90th Congr., 2d Sess., 7–8 Feb. 1968
GPO: HC$1.00; CFSTI: MF$0.65

Details are given on the NASA budget for fiscal year 1969 requesting appropriations for research and development, construction of facilities, and administrative operations. Supporting data are presented to show the program plans developed by the Offices of Space Science and Applications, Tracking and Data Acquisition, Advanced Research and Technology, and Manned Space Flight. The compromises necessitated by the cutback in the budget are discussed in relation to their impact on the overall space program and on a manned lunar landing by the end of 1969.
M.G.J.

N68-19969# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
AN ANALYSIS OF PROGRESS CURVE CONCEPTUAL ADVANCES AND PROGRESS CURVE USES, SINCE 1956
Vincent Colasuonno (M.S. Thesis) Sep. 1967 116 p refs
(GSM/SM/67-5; AD-664952)

The progress curve concept is traced in historical developments through 1956. The paper then concentrates on extensions of concepts through review and evaluation of articles and reports. Non-linearity is discussed, as is capital-intensive production and new estimating relationships. Innovations in its use are examined. These include nonhomogeneous production, value engineering, second source procurements, and optimal lot size. Present uses of the curve, factors in its make-up, and misuse of the concept are discussed. While parts of the overall learning effect can be optimized and/or quantified, qualitative factors still exist. A quantitative-qualitative view of the progress curve is therefore recommended.
Author (TAB)

N68-20231# Naval Research Lab., Washington, D. C.
FIRE EQUIPMENT TESTS ABOARD THE CVA-62 RELATED TO IMPROVED AIRCRAFT CARRIER SAFETY
H. B. Peterson, R. L. Tuve, E. J. Jablonski, R. R. Neil, A. W. Bertschy et al 30 Jan. 1968 61 p
(NRL-MEMO-1851; AD-665295)

A series of tests were conducted at sea for the purpose of evaluating the application of the twinned agents, Light Water - Purple-K-Powder, from the Twin Ball Fire Fighting Unit, application of Light Water from a helicopter, and P-K-P from portable extinguishers. Also studied were the characteristics of the NBC washdown nozzles as possible basis for the introduction of a Light Water based installed fire protection system for the flight deck. Wind speeds and patterns were measured at various heights above the deck to establish their role in fire fighting operations. The major portion of the work was done under 30 knot winds characteristic of the wind speed during aircraft launch and recovery and representing the most severe conditions for extinguishing fires. The air flow over the deck below the 6 ft level was found to be laminar in character with marked diminishment in speed at levels near the deck. Thus, the detrimental effects of wind on the discharge patterns of fire extinguishing agents was not serious in the down-wind direction but did severely limit the cross-wind agent reach. The water distribution pattern from the washdown nozzles offers good potential as a base for a fire fighting system which with Light Water will offer both fire extinguishing and ordnance cooling capabilities.
Author (TAB)

N68-20298# California Univ., Los Angeles. Western Management Science Inst.
AN ANALYSIS OF CONTRACTUAL INCENTIVES
Marvin Hienz Berhold (Ph.D. Thesis) Sep. 1967 191 p refs
Its Working Paper No. 129
(Contract Nonr-233(75))
(AD-665276)

In the model two persons are considered, a principal and an agent. The principal wants to motivate the agent to make an appropriate decision because the results depend on the agents decision. The principal will motivate the appropriate decision by relating monetary payments to a characteristic of the agents performance. This relationship between the monetary reward and the characteristic of the agents performance is called the incentive function. Government contracts as used in the weapons acquisition process provide an example of contractual incentives. The government is the principal and the contractor is the agent. The model concerns itself with the contractors problem of selecting an optimal production method subsequent to the time when the contract is specified. In addition the method concerns itself with the governments problem of specifying a contract which will motivate the contractor to accept the contract and subsequently to choose a production method which will minimize the net cost of the contract. Government contracts are characterized by the sharing ratio which indicates the proportion of the cost reduction which the contractor will receive. The model shows that under certainty the optimal sharing ratio is 1.
Author (TAB)

N68-20345# Office of Manpower Policy, Evaluation, and Research, Washington, D. C.
PUTTING RESEARCH, EXPERIMENTAL AND DEMONSTRATION FINDINGS TO USE
Jun. 1967 77 p refs
(Rept.-1; PB-176213) CFSTI: HC$3.00/MF$0.65

Every year the Federal government spends millions of dollars to finance experimental, demonstration, and research projects in one or another of the social sciences. Many of them produce valid and valuable findings on how to improve practices, techniques, services, and standards. There is, however, a considerable gap between the best available knowledge in almost any given field and everyday practice. The quality of life in our society can be upgraded if that knowledge can be more widely disseminated, given greater impact, and more extensively applied. This seems particularly true with reference to knowledge in the areas of human resource development and utilization, design of human environments, and health-related knowledge. Some suggested ways of facilitating knowledge utilization which grew out of the seminar on Putting Experimental, Research and Demonstration Findings To Use are reported. The participants were aware that not all suggestions are relevant to each type of demonstration activity, that the degree of application and the emphases selected are closely linked to availability of resources and to the particular program's key objectives, that many of the things suggested already are being done to some degree by some agencies, and that not all have been tested for efficacy. Author

N68-20391# European Space Vehicle Launcher Development Organization, Paris (France).
NOTE ON THE FORMAT OF DEVELOPMENT COST PLANS FOR ELDO PROJECTS
E. G. Vardy Jul. 1966 55 p In FRENCH and ENGLISH Revised
(ELDO-TM-P-3) CFSTI: HC $3.00/MF $0.65

This memorandum gives an outline of a common formula for the presentation of development cost plans for ELDO projects. Author (ESRO)

N68-20393# Universidad Autonoma de San Luis Potosi (Mexico). Escuela de Ingenieria.
STABILIZATION OF SUB-BASE AND BASE MATERIALS FOR PAVEMENT [ESTABILIZACION DE MATERIALES PARA SUB-BASE Y BASE DE PAVIMENTACION]
J. Fernando Carreon Sandoval 1967 121 p refs In SPANISH
CFSTI: HC $3.00/MF $0.65

An investigation is made of the stabilization of various materials used in the substrate and base of pavements. These materials include hydrated lime, cement, and asphalt. The discussion covers the objectives of each material, the equipment and methods used to test them, and examples of stabilization with each material. Transl. by R.N.A.

N68-20397# Massachusetts Inst. of Tech., Cambridge. Electronic Systems Lab.
OPTIMAL VEHICLE CONTROL FOR MERGING PROBLEM
Michael Athans and William S. Levine Nov. 1967 30 p refs
(Contract C-85-65)
(ESL-R-327; PB-176921) CFSTI: HC $3.00/MF $0.65

The report deals with the problem of the control of high-speed vehicles so that safe merging from two guideways into a single one takes place. The theory of optimal control is used to analyze the problem. Two main results are obtained: first, the optimal control of the vehicles is obtained for any given merging sequence and second, the best possible merging sequence is obtained. Author

N68-20417# European Space Conference, Paris (France).
REPORT OF THE ADVISORY COMMITTEE ON PROGRAMMES Final Report
Dec. 1967 127 p ref
(CSE/CCP (67)5) CFSTI: HC $3.00/MF $0.65

This report marks the accomplishment of the mission entrusted to the Committee by the European Space Conference during the Rome meeting in July 1967. European space policy, economics and institutions, launchers and propulsion techniques are examined in view of an integration of national and international European space programs. Alternative decisions are proposed. Programs of scientific satellites as well as of application satellites are laid down. ESRO

N68-20483*# Washington Univ., St. Louis, Mo. Dept. of Economics.
THE SHORTAGE OF SCIENTISTS AND ENGINEERS
Hugh Folk Feb. 1968 387 p refs *Its* Working Paper No. 6802
(Grant NsG-342)
(NASA-CR-93776) CFSTI: HC $3.00/MF $0.65 CSCL 05I

The labor market for scientists and engineers is examined in terms of the needs and salaries offered by business, research laboratories, government, and universities. Eight types of shortages and possible solutions to significant problems are considered under the general headings of salary rise shortage, dynamic shortage, controlled price shortage, projected supply shortfall, inelastic supply, national policy goal, limited pool of ability, and utilization of manpower. Both demand and supply for engineers and scientists are detailed, as is the functioning of this specialized labor market. Economic returns and outlook for employment are also treated in terms of types of positions, level of educational achievement, lifetime earnings, and other variables. M.W.R.

N68-20521 California Univ., Los Angeles.
MAINTAINABILITY CONSIDERATIONS IN SYSTEM DESIGN
Melvin Bernard Kline (Ph.D. Thesis) 1966 292 p
Available from Univ. Microfilms: HC $13.30/MF $3.75 Order No. 67-6166

Maintainability considerations in system design are discussed. The system life cycle is described with particular attention to the activities in the systems engineering phase. A general model of the system design process applicable throughout systems engineering is also described. Maintainability is considered as a system design parameter, in terms of its own set of design requirements. Since maintenance consists of those actions necessary to restore a failed system to operational status or to forestall a system from becoming a failed system, downtime is taken as the generally accepted fundamental measure of maintainability. Downtime, in turn, is further examined as to its components in terms of maintenance tasks of detection, diagnosis, correction, and verification. A four-dimensional conceptual model of maintainability design has been postulated, the components which are: 1. Life Cycle Design Stages; 2. System Levels; 3. Maintenance Tasks; 4. Maintainability Design Factors. Dissert. Abstr.

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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